AGRICULTURAL ENGINEERING

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AGRICULTURAL ENGINEERING

The Journal of Engineering as Applied to Agriculture

RAYMOND OLNEY, Editor

Vol. 7 AUGUST, 1926 No. 8

EDITORIALS

"A Profession of Service"

"THAT the next meeting of the American Society of Agricultural Engineers is the twentieth annual meeting will surprise those who regard agricultural engineering as a recent development. However, there is some reason for the view, for not until in recent years has the importance of this branch of engineering been realized. In fact it is not yet realized even by those who consider themselves well acquainted with engineering and its place and part in our industrial and commercial development. It will surprise even most engineers to know that this continent's greatest engineering achievement, the Panama Canal, is of less magnitude, less cost and less importance to our national prosperity than one of the oldest agricultural engineering achievements, the drainage of land. In such drainage, in construction of farm buildings, in developing farm storage systems for perishable and other crops, in clearing land and fitting it for irrigation, in irrigation itself, in farm mechanics, in the use of farm power ncluding electric energy, and in the many subdivisions of these subjects agricultural engineering has an important field and an essential work that cannot be done by any other branch of engineering. After twenty years the agricultural engineer and his profession are beginning to receive the recognition they deserve. Twenty years hence that recognition will be general wherever agriculture is an industry."

The foregoing is an editorial from the June 12 issue of "The National Stockman and Farmer," one of the leading representatives of the agricultural press of this country. This editorial is more than an excellent exposition of the field and importance of agricultural engineering; it is a splendid example of the recognition of the great need of this branch of engineering by one of the great factors contributing to the development of the agricultural industry, the farm paper.

Farm papers in common with the agricultural educational institutions, and even farmers themselves, have been slow to recognize that agriculture is an industry equally as much as any manufacturing enterprise and therefore as fully in need of the application of engineering principles and practices as is manufacturing. As a matter of fact, agriculture actually requires a greater variety of engineering that probably any other industry. The foregoing editorial, however, is a shining example of the sort of recognition that is so greatly needed by the agricultural engineering profession at the present time. Incidentally, it may be said that the job of educating those outside the profession to the need and importance of agricultural engineering and the ability of agricultural engineers to solve successfully any problem coming within the scope of this field lies largely on the shoulders of the agricultural engineers themselves.

Engineers Must Know Economics

TODAY the world is nearer solving the problem of production than it ever has been. The mechanical achievements have been marvelous enough but they relate no more merely to the development of natural resources and the devising of machinery. The engineer of the new day will need to know economics both in theory and in practice and he will need to be able to stand up on his feet and talk economics.

The engineer is learning, for example, that high wages and low costs go hand in hand, that low wages and low costs do not go together and that it costs in many trades $150 to hire and fire a good man. The engineer of the future will need to know that out of these new ideas of American production have come the secret of high wages, as Henry Ford and others have proved. Public ownership, waste in industry, demand and supply, costs, rentals and financing identified with mass production, mass management and mass ownership are problems facing the engineer.

The mechanical aspects of the factory system are more and more coalescing with economic phases, since it is now clearly recognized that the distribution of wealth is as essential as the creation of it. The pressure on engineering colleges during the past twenty years in a demand for supplemental courses in economics has been tremendous. It indicates the close of one epoch and the beginning of another in which analysis, deduction and prediction of economic developments in the mechanical world will be part and parcel of the engineer's task.

(EDITOR'S NOTE: The foregoing, of equal significance to agricultural engineers as it is to those in other branches of the engineering profession, is quoted from an address by Dexter S. Kimball, dean of the college of engineering, Cornell University, and president of American Engineering Council, before the spring meeting of the American Society of Mechanical Engineers.)

America's Timber Crop

THE American people have been told for a generation now that their timber supply will soon be all gone. A timber famine has been the subject of many articles, speeches and editorials. Most of us in this country, listening or reading of the decline in our timber supply, picture the lumbermen as a destructionist, hacking away at a great national resource.

The facts according to the best studies available are that there is plenty of softwood timber available in America for all present needs; and that properly guarded from fire, present forest areas in the great Western country will supply America's softwood needs for all time to come.

Much difference of opinion has existed in the past about the amount of standing timber in the United States and especially in the Western states. Until the last two or three years, studies of Western tree growth have not been available. Through the work of the Pacific Northwest Forest Experiment Station of the United States Forest Service, the Western Forestry and Conservation Association, the forestry schools of the Pacific Northwest, and some of the more progressive lumbering companies, studies are now completed to the point where facts can be given the American public. Some of the facts as compiled from these sources follow:

There is today more standing timber in the states of Washington and Oregon than there ever was in the original stands in the states of New York, Pennsylvania, Wisconsin, Michigan and Minnesota.

Timber now standing in all the states west of the Rocky Mountains totals approximately 1,134 billion board feet. This is more timber than was cut, according to the best studies available, in more than 100 years past from the forests of New York, Pennsylvania, Michigan, Wisconsin, Minnesota, Indiana, Ohio, New Hampshire, Massachusetts, Connecticut, Maine, Vermont and Rhode Island. These states in the past 100 years cut 794 billion feet of timber, or about three-fourths of the amount now standing in the states west of the Rockies.

Fifty-one per cent of all the standing timber of the United States is in Oregon and Washington and eighty per cent of the standing timber in these two states is Douglas fir. Approximately nine billion feet of Douglas fir is now manufactured in Oregon and Washington per year and the school

of forestry at the University of Washington places the probable growth of Douglas fir in Western Washington alone as five billion in old growth and three billion in the second growth. Oregon, which contains more Douglas fir than Washington, is not included in this growth statement. When this is done the total of new growth will be much more than the rate of present cutting.

Trees grow faster and to a greater height in the Pacific Northwest than in any other section in America. Also they grow in thicker stands. A Douglas fir forest will yield from 40,000 to 150,000 board feet per acre while an acre in an Eastern or Central state forest will produce but from 5,000 to 10,000 board feet.

J. B. FITZGERALD

West Coast Lumber Trade Extension Bureau

"Engineering as an Aid to the Farmer*"

THE farmer has a hard row to hoe. He puts in long hours to produce vital supplies which he sells at a low figure for city dwellers working short hours at high wages, who in turn produce goods which the farmer is compelled to buy at high prices, or go without. He has to struggle to get, keep, and pay such labor as he and his family cannot supply with their own hands. His business is so organized, largely by its very nature, that he has long periods of seasonal idleness, a fundamental drawback to efficiency of production. Farming, the oldest of the productive activities of man, remains the least affected by those modern methods which have increased man's productivity, and in so doing have likewise increased his capacity for consumption, and his ability to pay for that increase.

Other great industries have met changed conditions by large scale production, are drawing on great pools of capital by labor-saving machinery, by scientific research, and by utilizing to the full the services of the engineer. Many things conspire to keep the farmer behind the other classes of producers in such modern adaptations. Millions of capital en masse do not exist for the farmer as for the manufacturer, or the transporter, or the distributor of goods. Up to the safe mortgage limit, land or chattel, he can borrow money, but only as an individual. His is indeed a large class of highly individualized and widely scattered persons. He has made his gestures toward co-operation, and they are becoming gradually more effective, in spite of the fact that those who represent him sense his political power more than they seek his individual prosperity, with the result that his accomplishments in co-operation are most notable where they perhaps do him the greatest harm in the long run, that is, in getting class legislation.

No wonder then that he or those who represent him are continually exploring new economic wildernesses in the vain hope that somewhere, somehow, will be found the formula of escape. Free silver in the nineties and equalization fees in this year of grace bear little resemblance as basic means, but the ends sought are precisely the same; they both represent the struggling effort of the agricultural producer to lift up this one great essential of living to the same scale and base as its eternally warring brother, industrial production. All such efforts are expedient. They can affect, if at all, only the temporary relation of the two great divisions of human activity. In the long run, the pendulum now setting high toward industrialism will turn, and the demand for food and clothing from a factory-covered world will increase the attractiveness of the business of raising the wherewithal for this food and clothing.

Meanwhile there is a gradually growing appreciation of the long-time efficacy of engineering as a saving grace. Economics as exemplified in what is called business may alter earlier results, but those most deeply interested in agriculture appreciate that for the long-time pull it is science which will win out. In scientific research the farmer has had far more done for him than any other great producer. How far he has gone in utilizing the numberless data and conclusions placed at his disposal is another matter; not far, probably, compared with the producers in the industrial field. For the most part, however, this application of science has been highly specialized. It has not until recently recognized any engineering relation, but within the past two decades this has been changed. The science of agricultural engineering is growing up, and that science is slowly making its impress on the struggling industry toward which it is directed. The article in this issue by Professor Ayres is an interesting exposition of how this agricultural engineering has grown, and how its development in our schools is progressing.

It would be instructive to know how much the present plight of the farmer is due to his lack of appreciation and use of engineering services. When it comes to employing competent engineers, what percentage of the farmers of the country, even co-operatively, have ever paid a dollar to an engineer, except for surveying? Where it has been done, it has been generally for laying out drainage or irrigation work, or perchance road, and generally through governmental agencies at that. Indirectly the farmer gets the benefit of a large amount of engineering and other technical service, through the purchase of farm and house equipment, but he does not recognize that as engineering. The forward looking farmer is fully appreciative of the advances that have been made by the scientific agriculturist. That the engineer, too, has something to offer has not as yet made much progress in his consciousness. And yet, to cite only one fairly remote example, those efforts to market his products which are slowly going forward under head of co-operative plans, are at bottom merely engineering devices, or they are subject to those investigations, analysis and actions that form the basis of engineering operation.

If the farmer as a class will gradually get away from the idea that some kind of magic formula or legal device will act as substitute for scientific development he will, helped out by the normal swing which is bound to come toward his industry, move even faster than he is now moving toward that equality of reward with the industrial producer which he now so eagerly seeks, and which in a properly balanced world he must have.

*An editorial from the June 24, 1926, issue of "Engineering News-Record.

If You Are Hiding Your Light Under a Bushel—

While agriculture is the oldest of all industries, the application of engineering to agriculture is still a comparatively new development. The need therefore of accurate and up-to-date knowledge in this field is indeed great. Individual members of the agricultural engineering profession possess, in the aggregate, an abundance of valuable information and data that should be desseminated "for the good of the order." Therefore, if you are hiding your light under a bushel, it is urged that you permit it to shine forth through the columns of this journal.—The Editor.

Grain Storage, Drying and Shrinkage Problems*

By E. W. Lehmann

Mem. A.S.A.E. Professor of Farm Mechanics, University of Illinois

DURING the past two seasons the departments of agronomy and farm mechanics have been conducting a cooperative research project on the storage and handling of grain and other crops at the Illinois Agricultural Experiment Station. The department of agronomy is interested primarily in the physiological aspects of the problem, while the department of farm mechanics is interested in the mechanical aspects. Both departments are interested in working out a satisfactory and economical solution to a problem with which the farmer is often faced.

The condition of the corn crop in 1924 was an important factor in getting this piece of experimental work under way. While the first year's work was devoted to soft corn studies, the plan of the project also includes the drying of seed corn; the drying, storage and shrinkage of soybeans and small grain; the artificial drying and curing of hay crops; the comparative shrinkage of grain harvested with the combine and by methods commonly followed under Illinois conditions, etc.

The experimental equipment consists of eight storage units eight feet wide, ten feet long and ten feet high. The outside construction is of crib boards, the inside to be lined as the occasion demands. These units are mounted on flanged wheels and set on railroad track. Two hundred feet of track is provided, and at the center is a track scale, giving ample space on each side of the scale to accommodate all of the units, so that they can be moved across the scale to determine the loss of weight during the period of drying. An electric hoist of the drum and cable type that can be operated from any point along the track is used for moving the units. Contiguous to the scale a small building is provided with heating plant, motor and blower equipment for forcing either heated or unheated air through the material being dried.

First Year's Study. The work of 1924 was devoted entirely to the problem of soft corn. The condition of the crop made it an easy matter to secure corn for the tests. The plan of the tests was as follows:

Unit No. 1 had no ventilation other than the cracks between the crib boards. It was filled with mature corn, 23.8 per cent moisture content, to serve as a check and to determine its change in condition and rate of shrinkage.

Unit No. 2 was ventilated with an A-shaped ventilator extending through the center, in addition to the cracks between crib boards. It was filled with soft corn 43.0 per cent moisture content.

Unit No. 3 was ventilated with a central air shaft extending through the center and with lateral tile extending out on both sides in addition to the cracks between the crib boards. It was filled with soft corn, 42.6 per cent moisture content.

Unit No. 4 was left empty to serve as a check on the variation of weights of the units due to weather conditions. The sides were of ordinary crib board construction.

Unit No. 5 was provided with a slatted, false bottom; the inner wall was sealed with Celotex. It was filled with soft corn of 37.1 per cent moisture content and dried by forcing unheated air up through the corn.

Unit No. 6 was provided with a central ventilator designed so there would be a fairly uniform thickness of corn on either side and above. The sides were of ordinary crib board construction. It was filled with soft corn, 37.8 per cent moisture content and dried by forcing unheated air into the central ventilator from which it passed through the corn laterally and upwards.

Unit No. 7 was arranged the same as No. 5 and filled with soft corn 36.9 per cent moisture content, and dried by forcing heated air through it.

Unit No. 8 was arranged the same as No. 6 and filled with soft corn 37.8 per cent moisture content, and dried by forcing heated air through it.

All moistures are given as the average percentage moisture in the grain and in the cob. All of the units were weighed at least once each week to determine the rate of shrinkage, and during the period of forced drying they were weighed at shorter intervals. Results of these tests are shown in Tables I, II, and III.

Plan of Work for 1925-1926. To continue the study of the shrinkage of mature corn, Unit No. 1 was not emptied, the studies being continued over a second year. Unit No. 6 has been filled with mature corn so its shrinkage can be studied

Table I. Results of Drying Ear Corn - Natural Drying, 1924-1925

Units	Date filled	No. bushels when filled	Kind of corn	Method of ventilation	Moisture Content - Per cent			
					When filled Nov.15	Jan.10	Mar.28	Apr.25
1	Nov.15	256	Mature	None - Ordinary crib	23.8	20.2	16.2	13.3
2	Nov.15	254	Soft	A-shaped	43.0	33.3	19.5	9.7
3	Nov.15	246	Soft	Shaft and tile	42.6	33.0	17.1	9.7

*Paper presented at a meeting of the Farm Power and Machinery Division of the American Society of Agricultural Engineers at Chicago, December, 1925.

The crop storage experimental plant at the Illinois Agricultural Experiment Station where studies of grain storage, drying and shrinkage problems are made

Table II. Results of Drying Soft Ear Corn by Forced Air

Units	Date filled	No. bushels when filled	No. bushels when dry	Ave. Outside humidity while forcing air	Ave. Outside temperature while forcing air - degrees F	Temperature of heated air - degrees F	MOISTURE CONTENT (2) Dec.13	Dec.30	Mar.14	After drying	Pounds water removed by forced air	Total lbs. water removed	Cost per 1000 lbs. water removed by forced air (3)	Cost per 1000 lbs. total water removed (3)	No. of hours air forced	Rate in cu. ft. per min.	Power used - k.w.h.	Fuel oil used - gals.
5	Dec.13	223	189.0	67.0	47.6		37.1		34.5(1)	25.80	1743	2378	$5.33	$3.91	203	1015	185.7	
6	Dec.13	251	193.5	67.0	47.6		37.8		27.4(1)	19.30	1499	4036	6.45	2.39	268	1055	193.0	
7	Dec.13	221	156.0	80.6	15.2	125	36.9	10.32		10.32	4586	4586	4.38	4.38	123	855	135.0	191
8	Dec.13	254	203.0	80.6	15.2	125	38.0	22.50		22.50	3542	3542	5.63	5.63	157	845	134.0	189

NOTE: Unit 5 - Tight sides; unheated air forced in at bottom (1)
Unit 6 - Slatted sides; unheated air forced in at center (1)
Unit 7 - Tight sides; heated air forced in at bottom
Unit 8 - Slatted sides; heated air forced in at center

(1) The corn stood in Units 5 and 6 from December 13 to March 14 before the forced air was started. (The blowing of forced air was delayed until weather conditions were favorable for drying with unheated air.) The loss in moisture content in these cribs between December 13 and March 14 was due to natural drying.

(2) All moisture readings are given as average percentage of moisture in grain and cob.

(3) Cost of fuel oil at 7 cents per gallon and electrical power at 5 cents per kilowatt-hour.

NOTE: There was considerable damage in some of the dried corn. The condition of the corn was best in Unit 8, and the units ranked as follows in this respect: 8,7,6,5.

along with the corn in No. 1.

Shrinkage of Wheat. The use of the combine in Illinois created considerable interest in the condition of the wheat when harvested with the combine as compared with wheat when cut and threshed by the ordinary method. A number of people were of the opinion that special drying equipment would be needed to put the grain in shape for storage when it was harvested with the combine. Much to the surprise of many of us, the moisture content of the grain from the combine was no greater, and in some cases, was even less than the grain from adjacent fields cut with a binder and threshed with a threshing machine.

To check the shrinkage of wheat when threshed from the shock and by a combine, on July 23, 1925, Unit No. 2 was filled with shock threshed wheat, and Unit No. 3 was filled with wheat threshed by a combined harvester-thresher. From July 23 to November 28, 1925, there has been no shrinkage but a slight gain in weight of approximately 0.9 per cent. This gain in weight may be accounted for by the large amount of rain, and consequently the high relative humidity during the months of October and November.

Drying Seed Corn. One of the problems of seed corn drying is the proper temperatures and rate of drying. Three units were filled this fall (1925) with seed corn. In one the corn is to be dried by natural ventilation; in one by forced, unheated air, and in the third, by forced, heated air. In a nearby barn additional corn is stored as is commonly done on the farm. Test samples for germination are being taken at regular intervals.

Drying Soybeans. On test it was found that the soybeans cut with the combine had a much lower moisture content than the beans threshed from the shock on the same day. For example, beans cut on one farm with a combine tested 14.5 per cent moisture content and on an adjacent farm, when threshed from the shock, tested 24.6 per cent moisture content. Another example of moisture content of samples taken the same day from two farms several miles apart was 17.6 per cent and 23.8 per cent, or 6.2 per cent in favor of the combine. It is interesting to note that the quality of the beans from the combine is much better than from the shock as indicated by germination tests. Many beans from the shock are of practically no value for seed.

The above condition was not anticipated; in fact, the idea was so prevalent that the beans from the combine would need to be dried that one company built a portable drier and had it on the ground when the harvesting of beans was started. This was a batch type of drier; the beans were first elevated into a bin through which hot air was forced, then they were transferred into a bin through which cold air was forced with the result that the moisture content was reduced only about one or two per cent and many of the beans were cracked in the process of drying. The operation of the drier was discontinued before making a complete test. It is believed that with a drier of the continuous type, the beans could be dried without as much cracking.

Conclusions. From the results secured to date we would not be justified in drawing any very definite conclusions. However, it is of interest to note that on the basis of dockage due to spoiled corn in the various cribs when the grain was sold, the cribs rated in the following order: 8, 7, 3, 6, 2, 5. It would indicate from this that for quick drying and for a minimum of loss of grain, the forced heated air is the most effective. However, the cost would have to be balanced against the loss by the other methods. Very good results may also be secured with a well-designed crib and good natural ventilation, provided by an areator and some sort of ventilating ducts to draw the air through the corn.

(AUTHOR'S NOTE: The credit for the preparation of the tables accompanying this paper belongs to R. C. Kelleher, Department of Farm Mechanics, University of Illinois.)

A Power Advantage

AT THE present time the farmer is trading the products of his labor for the products of the factory on a basis of about five to three. The reason that agriculture is lagging behind manufacturing is because it is not using mechanical power and labor-saving machinery anywhere near the extent to which they are being used in the manufacturing industries. In other words, industry's advantage is a power and machinery advantage.

Table III. Relative Efficiency of Different Units for Approximately Equivalent Moisture Reduction

Units	No. bushels when filled	No. bushels when dry	Reduction in Moisture Content - per cent: From	To	Difference	No. hours air forced	Rate in cu.ft. per min.	Power Used - k.w.h.	Fuel oil used - gallons	Cost per bushel dried corn (4)
5	223	177.0	37.1(1)	21.0	16.1	359.0(3)	1015(3)	298.7		$0.085
6	251	197.5	37.8(2)	21.0	16.8	278.0	1055	142.0		0.036
7	221	176.5	36.9	20.8	16.1	114.3	855	91.7	120	0.074
8	254	203.0	38.0	22.6	15.4	183.0	845	134.0	189	0.098

NOTE: Units are the same as indicated in Table II. Tables II and III show results of the same test. Table III gives data for each unit at its particular stage in the drying process when the moisture reduction in all units was approximately equivalent.

(1) Reduced by natural drying 37.1 to 34.5 per cent
(2) Reduced by natural drying 37.8 to 27.4 per cent
(3) 268 hours at 1015 cubic feet per minute and 91 hours at 1535 cubic feet per minute
(4) Cost of fuel oil at 7 cents per gallon, and electrical power at 5 cents per kilowatt-hour

A Topographic, Soil, Alkali, and Drainage Survey of an Irrigated Farm in California

By R. Earl Storie

Assoc. Mem. A.S.A.E. Junior Soil Technologist, University of California

THE purpose of this article is to present a type of farmstead map showing features that the author considers within the realm of agricultural engineering and an important part of the work of an agricultural engineer, particularly one specializing in land reclamation under irrigation.

The following features are shown on this map: Culture such as buildings, fences, field boundaries, ditches and drains; surface elevations by means of contours representing a six-inch difference in elevation; the soil types with a profile of each type in the legend; three grades of alkali concentration and the elevation of the water table at each test well before a deep drain was constructed in 1925 and afterward in 1926.

The construction of such a map involves the study of the farmstead layout and the plotting of it to scale. One of the easiest and quickest ways of doing this is by means of a small plane table and an ordinary engineer's steel tape. Each feature can then be accurately located in the field and transferred to the map. The completed map can be used in securing the acreages of each field. The map accompanying this article was constructed to the scale of 200 feet to the inch. Such features in themselves are valuable in aiding the farmer to better carry on his farming operations from year to year and in having an accurate map for future reference.

Topography. A knowledge of the topography is very necessary in any irrigation or drainage work. In most cases money spent for engineering assistance by those contemplating work along these lines will save time and worry later on. Such a map as that shown with a 6-inch contour interval is a great aid in the locating of ditches and the general layout of any system of farm irrigation. Even after the farmer has been irrigating a number of years he may desire to recheck his land in a different way and such a map is a great aid to him. It is needless to point out the desirability of having elevations of a farm before any drainage work is contemplated.

Soils. We now find agricultural engineers engaged in reclamation making a close study of soils. They realize that

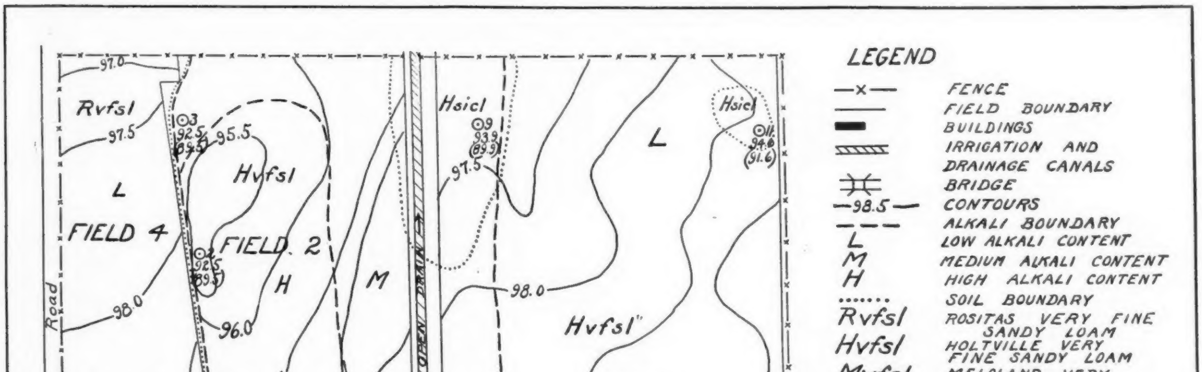


Fig. 1. A map of Pampas Ranch. A map of this nature can be of great help in the layout and planning of irrigation work, in drainage work, alkali reclamation as well as of general use

Fig. 2. (Upper left) Securing elevations for topographic map by means of level. Of use in irrigation and drainage development. Fig. 3. (Lower left) Boring hole with soil auger, noting soil characteristics and securing sample of soil for alkali determination. Fig. 4. (Middle) Boring hole for test well. Used to obtain height of underground water table. Fig. 5. (Right) Construction open drain. The water table was lowered three feet by means of one such drain through the Pampas Ranch. The subsoil was permeable permitting a lateral movement of water into the drain.

a knowledge of the soil type is essential; that such a study gives useful information on the utilization, development and handling of land. In irrigation and drainage reclamation work it is useful to have soil information available.

The U. S. Bureau of Soils in their surveys recognize the soil type as the unit having definite characteristics in the field which distinguishes it from other soils. The soils are shown on this map by types, using the Bureau of Soils nomenclature. For insatnce, the Rositas very fine sandy loam (Rvfsl) shown on the map is a light brown very fine sandy loam on the surface to a depth of twelve inches. The subsoil consists of a mixture of a light brown very fine sand and fine sandy loam extending to a depth of more than six feet. This is shown on the profile accompanying the map. This soil differs from the Meloland very fine sandy loam (Mvfsl) in having a porous subsoil, the Meloland soil having a silty clay subsoil of impervious character. Such characteristics as these are important to know in planning irrigation and drainage work on these soils. The Holtville very fine sandy loam, Holtville silty clay loam and the Rositas very fine sandy loam soils differ from the Meloland very fine sandy loam soil in having more pervious subsoils and therefore responding quickly to drainage. It can readily be seen what value this information would be to a drainage engineer.

Alkali. A large proportion of our desert soils contain an accumulation of alkali or alkali salts in harmful quantities. It is within the province of the agricultural engineer to try to bring such land into useful production. Such work involves the study of the drainage situation, the topography, the soils, the quantity of alkali present and the kind of alkali. Such a study was made on the Pampas Ranch and the results are shown on the map. The alkali content of the soil is shown in three grades; namely, high (H), medium (M), and low (L). Those areas classified as high (H) have such a high concentration of alkali in the surface foot that the growing of most crops is impossible under present conditions. Alkali-resistant crops can be grown on the areas classified as medium (M), or other crops if the soil is handled properly. The areas classified as low (L) have a sufficiently low concentration to make possible the growing of practically all farm crops.

Alkali determinations were made by means of the Wheatston Bridge. Surface indications of alkali and crop tolerance aided the author in making this classification and drawing the boundaries between the different grades. No black alkali was found.

A great deal of the alkali accumulation on this particular ranch was caused by an unusually high water table in 1925; the rising water table brought the soluble salts to the surface from lower depths. A drain nine feet deep was constructed in the fall of 1925 through the center of the ranch which has lowered the water table to such a depth that the owner can now start reclamation.

With the pervious subsoil conditions existing and the results secured by the recently constructed drain in lowering the water table, it is the opinion of the author that the place can be successfully reclaimed by washing the alkali down into the porous subsoil and laterally into the drain.

Drainage, Water Table Elevations. Accurate data on water table elevations is very desirable in many irrigated districts prticularly where alkali is present. In the handling of land containing alkali it is very necessary to keep the water table at a safe depth, otherwise the alkali will rise to the surface of the ground and prevent or limit the growth of crops. An accurate measurement of the height of the underground water table and the fluctuations occurring can be secured by having a number of permanent test wells on a farm. This is particularly desirable in an irrigated district where there may be fluctuations due to canal seepage or overirrigation to such an extent as to be dangerous.

On this map of the Pampas Ranch twelve test wells are shown with the elevation of the water table in 1925 before the drainage ditch was constructed, and also the elevations in April, 1926, after the ditch had functioned for a few months.

Before the drainage ditch was constructed in 1925 the average depth to water was about three feet. The average depth to water is now about six and a half feet, or a drop of three and a helf feet due to action of the deep drain. Test wells located 1000 to 1300 feet from the drain show a drop in the water table of three feet. Drainage in this distance would not have occurred so readily had the subsoil been less porous.

Earth Floor Covering for Bridges

By R. M. Gray

AN INTERESTING use of earth on the Liberty Ranch, California, is that of an earth wearing surface on bridges. Two such bridges were built with heavy stringers placed to carry the load and with two-by-four flooring spaced one-half inch in the clear. This flooring was then covered with heavy roofing paper with about 4 inches of earth on top.

After nine years of use, the two bridges are in very good condition, some trouble being experienced with the mud sills on one bridge, and on the other, the heavy trucking last fall took out about two square feet of earth and roofing paper. The flooring thus disclosed, and also inspection from the under side, showed it to be in perfect condition with no signs of deterioration or rotting. Repairing damage done will be far easier and cheaper than could be expected on the usual farm bridge of like age.

Crankcase Dilution in Kerosene Tractors*

By L. G. Heimpel

Mem. A.S.A.E. Professor of Agricultural Engineering, Macdonald College, Quebec

EVER since the development of the internal-combustion engine employing some form of circulating system for the lubrication of the cylinders and the various bearings enclosed in the crankcase, dilution of the lubricating oil by the fuel used has added much to the troubles of the user, the manufacturer and the engineer. In the early days of the automobile industry, when gasolines had a gravity of 72 and 74 degrees Baume, there were, of course, no such troubles. The oil used in the crankcases of engines prior to 1913 was often of a consistency similar to that of cream separator oil, or what was called dynamo or fine engine oil, yet the lubrication was splendid and engine wear comparatively light. With fuels of such high volatility dilution of the lubrication oil was hardly possible.

With the tremendous expansion of the automobile industry, however, the available supply of light or "high test" fuels soon disappeared and the oil companies were forced to incorporate in the gasoline petroleum distillates of higher end points to provide a sufficient supply.

The great war aggravated what, in this respect, already was a serious situation. Everyone acquainted with the nature of the gasoline sold from 1917 to the present time can testify to the lack of volatility as indicated by difficult starting in cold weather and the necessity for frequent changes of cylinder oil. It is interesting to note what has happened the end point temperatures of the distillates sold as gasoline from 1915 to 1921. According to figures from United States Bureau of Mines, the average gasoline sample in 1915 had an end point of about 345 degrees F.; in 1917 this point had advanced to about 385 degrees F.; in April, 1919, to about 420 degrees F., and in January, 1920, to about 430 degrees F., where it has remained in a general way since. It is the nature of the fuel used since 1917 which is to blame for the more serious dilution of lubrication oils in the automobile engine, and in no way is the magnitude of these troubles more strikingly illustrated than in the following quotation from a paper on this subject by W. F. Parish, an eminent lubrication engineer, in 1923, in which he says, in part:

"The consumption of pistons, piston bushings and piston rings increased 1480 per cent from 1914 to 1923, and that of piston pins 1380 per cent. Registration of new cars over the same period increased only 700 per cent or about one-half that of the worn-out and replaced parts.

"The value of replacement parts has increased from being $11,000,000 in 1914 to $198,000,000 in 1923; this is an increase of 1800 per cent. When we add the cost of service labor, the public charge is approximately $450,000,000.

"These figures do not take into consideration replacement parts for used cars which are repaired by dealers or factory service stations. About 2,000,000 cars per year are so handled. This would add another $50,000,000 to the cost of poor lubrication due to dilution."

The damage due to increased dilution of the crankcase oil, as less volatile fuels had to be utilized, can in the face of these figures hardly be doubted. But we must remember that these are based on experiences with engines using gasoline, and, if this is so, how much greater must be the rate of dilution and how much greater the damage when kerosene is used as a fuel in these engines.

Kerosene has for quite a few years been advocated by some stationary engine and tractor manufacturers as a fuel for their engines, or perhaps we should say, the public has demanded that engines be equipped to burn kerosene. The writer used it as early as 1912 in large tractors on the Canadian prairies. The engines in which its use was most successful were, however, of the fresh oil lubricated type, such as the old Hart-Parr, the Rumely, the Pioneer, and, later, the Mogul and Titan engines of the International Harvester Company. Many of the first mentioned makes of machines, while they were exceedingly heavy and clumsy, leaving much to be desired as tractors, showed tremendous length of life so far as the power plant is concerned, and it is very likely that the fresh oil lubrication system is to be credited with this.

Of late years those of us who have had opportunities to observe the performance of some of the later types of multi-cylinder engines have, no doubt, seen plenty of cases indicating serious dilution when these engines were run with kerosene as fuel. One case in particular remains very clear in my recollection. This machine, for no apparent reason, refused to drive a thresher which, up to a few days previously, had not been a difficult load. The oil guage showed that the crankcase was almost full; after a few hours of attempted threshing during which the engine labored badly it was noticed that the oil indicator had risen perceptibly. Upon inquiry of the owner it was found that no new oil had been added for two days and that the guage showed a little over half full when the last fresh oil had been added. The dilution in this particular case was easily more than 50 per cent. Experiences such as this and a knowledge of the increase of crankcase oil dilution in automobile engines prompted the undertaking of the experiments which we will outline here.

It would be possible under laboratory conditions to run a tractor under load for given lengths of time and to take samples of the oil at intervals from which the amount of dilution could be determined. This would, however, give us conditions as they exist with one engine only; it was decided, therefore, to secure the cooperation of tractor owning farmers of which there are several in the vicinity of Macdonald College. The instructions were that samples should be taken at five hour intervals up to forty hours if possible and that no

*Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at Schenectady, N. Y., December, 1925.

This graph shows the amount of dilution an oil can carry before its lubricating powers are impaired

new oil should be added while samples were being taken. Adding of oil when necessary was taken care of by removing all the oil after fifteen or twenty hours of work and starting again with new oil in the crankcase. When after fifteen or twenty hours more work more oil was needed some of the fifteen or twenty hour oil previously removed was added. Samples were secured in this way from four tractors. The work done by them during the tests consisted of both draw bar and belt work. The oil used consisted in three cases of Imperial kerosene tractor oil and in one case of Mobil B.

The percentage of dilution was secured by distillation under atmospheric pressure, using 100 cc. samples in 250 cc. Engler distillation flasks, the flasks having previously been encased in a jacket of a magnesium and asbestos mixture. To ascertain the amount of light distillate to be expected from the oils used, samples of new oil were distilled and the amount coming over before the approximate end point of commercial kerosene was reached was recorded and deducted from all diluted samples distilled later.

The end points of the fuel used were arrived at by the addition of a given amount of fuel, usually 10 cc. to 90 cc. of the previously distilled new oil, and the temperature at which the 10 cc. of fuel came off was taken as the end point of the fuel in question. The end point of the gasoline used was found to be about 432 degrees F. and that of the kerosene was found to be 547 degrees F.

From two of the engines two sets of samples were secured, one with kerosene and one with gasoline as the fuel. A great deal of work has already been done with the latter fuel, so that one or two check samples were thought sufficient for our purposes.

Engine No. 1 was a Fordson tractor in which compression was poor owing to badly worn rings. The tests were run during the months of September and October, but there were no exceptionally cool days during the run. The needle valve was kept adjusted to a moderately lean mixture at all times. The dilution in this first engine was, however, excessively high, running as follows:

5 hours	17 per cent
10 hours	26 per cent
15 hours	24 per cent
20 hours	38.5 per cent

Burning gasoline this engine showed the following rate of dilution:

5 hours	3 per cent
10 hours	4 per cent
15 hours	5½ per cent
20 hours	6½ per cent

No. 2 engine was also a Fordson which showed the following rate of dilution when using kerosene:

5 hours	5.25 per cent
10 hours	10.5 per cent
15 hours	13.5 per cent
20 hours	16.5 per cent
25 hours	21.0 per cent
30 hours	15.5 per cent
35 hours	17.0 per cent
40 hours	18.0 per cent

On gasoline the dilution was as follows:

5 hours	4.5 per cent
10 hours	5.0 per cent
15 hours	4.5 per cent
20 hours	7.75 per cent
25 hours	6.25 per cent
30 hours	10.5 per cent
35 hours	11.5 per cent
40 hours	8.0 per cent

This engine was in splendid mechanical condition and was in the hands of a good operator.

The small percentage of dilution when gasoline was used as fuel is worthy of note. This is less than is generally found to be the case in automobiles, and is no doubt due to the fact that the tractor is always subjected to a heavier and more uniform load than the automobile engine, thus maintaining a higher engine temperature, lessening dilution.

No. 3 engine was a new machine, a McCormick-Deering 10-20. Only one set of samples was secured from this machine and this with kerosene as the fuel. Dilution was as follows:

5 hours	3.75 per cent
10 hours	8.0 per cent
15 hours	13.5 per cent
20 hours	20.0 per cent
25 hours	24.0 per cent
30 hours	27.0 per cent
35 hours	30.5 per cent
40 hours	32.5 per cent

No. 4 engine was another Fordson. The work done during the test was largely belt work of a more or less intermittent nature, which would account for some of the excessive dilution noticed in this set of samples. The rate of dilution was as follows:

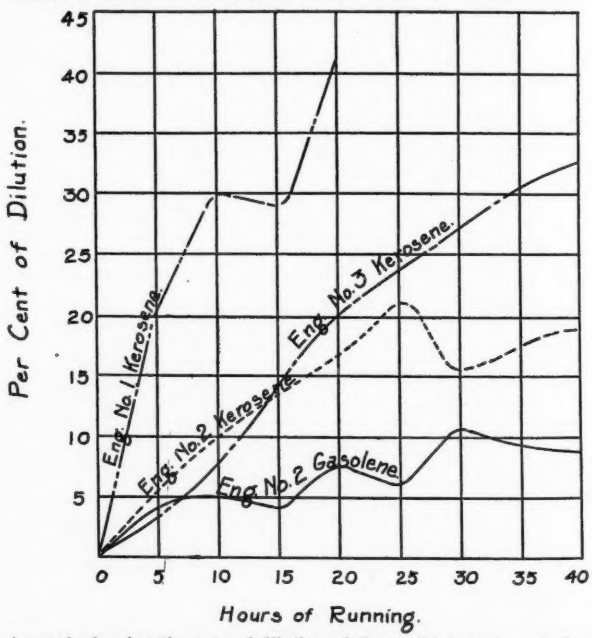
5 hours	15 per cent
10 hours	54 per cent
15 hours	61 per cent
20 hours	67 per cent
25 hours	26 per cent

After distilling these samples a visit was paid the engine in an effort to locate the cause of such tremendous dilution. It was found to be due to the use of an excessively rich mixture. The policy of the operator seemed to be to leave needle valve alone; the result was an overly rich mixture causing dilution.

The discrepancy in the percentage of dilution between the 20 and 25-hour samples can be due only to some mishap in the taking of the sample and should, we believe, be disregarded. The excessive dilution occurring in this series of samples can be due only to a combination of all the forces having a tendency to cause it; namely, poor compression, rich mixture, cool weather and an intermittent load. All of these existed in connection with this tractor during the test run.

Reviewing these results we find that the highest percentage of dilution where gasoline was used as fuel 11.5 per cent in engine No. 2; this in 25 hours. Engine No. 1 showed 6½ per cent in 20 hours. On the other hand, the dilution present in engine No. 2 was 21 per cent in 25 hours, when kerosene was used as a fuel, 38.5 per cent in 20 hours in engine No. 1, 32.5 per cent in 40 hours in engine No. 3, and 67 per cent in 20 hours in engine No. 4.

The next question is, how much dilution can an oil absorb without definite damage to its lubricating qualities? The answer to this is to be found in work done by Stratford and



A graph showing the rate of dilution of three of the engines during the tests at Macdonald College. Note the small amount of dilution in Engine No. 2 when gasoline was used as fuel

Parish in their investigations of this subject in connection with automobile engines. Their findings are to the effect that when an oil becomes thinned to the point where it has a viscosity of 180 seconds Saybolt at a temperature of 100 degrees F. its lubricating qualities are seriously affected. Stratford calls this point the critical point in the viscosity of a gas engine cylinder oil.

An extra heavy oil has a viscosity of about 550 seconds Saybolt at 100 degrees F. and when diluted with 16 per cent of fuel its viscosity will be lowered to the critical point mentioned above. Light motor oil requires only two per cent of dilution to make it too thin for effective lubrication in gas engines. In two of the tractors from which we distilled oil samples an extra heavy oil would be thinned down to 180 seconds Saybolt at 100 degrees F. in from five to six hours of operation, while in the case of the two engines giving lowest rates of dilution the critical point in the condition of the oil was reached after 15 or 20 hours of operation.

The above results seem to indicate very clearly that a close relationship exists between the mechanical condition of the engine and the rate of dilution. Engine No. 1, for instance, had very poor compression, hence a much heavier fuel consumption accompanied by heavy dilution. Engine No. 2 was of the same make, but in good condition and the percentage dilution was much smaller. In all these engines, however, the dilution resulting from the burning of kerosene is much heavier than any oil can bear and still maintain its lubricating value. Not many tractor users change oils more frequently than once in forty hours of operation. It is therefore safe to assume that about half of the time the average kerosene-burning tractor is at work it is suffering from lack of proper lubrication.

In conclusion, it is difficult to point to any easy way out of this problem. The farmer wants cheap fuel, and so long as there is a difference of five cents a gallon or more between the cost of gasoline and that of kerosene many will prefer to buy the latter. In the light of the above findings, however, it would seem desirable to advise against the use of kerosene in any but "fresh oil" types of engines. Changing the oil every 20 hours would, of course, be sufficient to insure reasonably good lubrication, but is very expensive and exceedingly wasteful of oil unless some simple, effective and inexpensive method of reclaiming the oil is developed. The future offers, if anything, less light and more heavy fuels so that the use of heavy fuels must be provided for. Whether this will mean a return to the fresh oil system of lubrication, or whether a radical change in the type of tractor engine is required, is the problem confronting the designer, the engineer and the manufacturer.

(ACKNOWLEDGMENTS: The author is greatly indebted to the assistance of C. M. Baskin, of the Imperial Oil Company, Montreal, Canada, for his advice in connection with this work, also to William F. Parish of New York City, whose previous work on crankcase dilution in connection with automobile engines was of great value.)

A. E. S. C. Yearbook Records Healthy Growth in Standardization Movement

THE movement toward standardization of industrial products has been considerably extended during the past year; and savings from standardization work are constantly growing in magnitude, according to the yearbook of the American Engineering Standards Committee, just issued. More than 200 definite standardization projects are in process or completed under the auspices of the A.E.S.C., and 365 national trade associations, technical societies and government bureaus are cooperating in the work through some 1600 representatives.

The general adoption of a comprehensive system of limit gaging developed by a representative committee of experts under the A.E.S.C. and approved during the past year, can, it is estimated, produce savings for American industry approaching a billion dollars a year. Two other projects of wide importance and interest are the standardization of drafting room practice, so as to provide a desirable uniformity in the methods and conventions of mechanical and other drawings used in industry; and the standardization of the methods of graphically presenting facts, both of which are to be undertaken through committees of experts that will shortly be organized.

Progress has been made on some 50 safety codes applicable to factories; and codes for paper and pulp mills, elevators and escalators, and for manufactured gas, were completed and approved during the year.

Nineteen standardization projects dealing with the mining industry are now under way. A very important code covering the rock dusting of coal mines to prevent the coal-dust explosion hazard was recently approved. The casualty insurance companies which cover mine insurance have announced through the associated companies that they will in future not issue compensation policies on gaseous or dusty mines that are not rock-dusted, and that after October 1 they will cancel policies already in force on such mines.

For the convenience of American industry, the A.E.S.C. is maintaining a file of specifications to be sold at cost. These include standards issued by all of the foreign standardizing bodies with which it regularly exchanges information and standards, and also those of all the national trade associations and technical trade associations and technical societies in the United States which have issued standards and specifications. This is done as a means of cooperation in the important work represented in the National Directory of Commodity Specifications, recently published by the Department of Commerce.

The A.E.S.C. maintains an extensive file of specifications that are constantly referred to by engineers and experts in every field. About 7000 standards are available for examination and reference in this way. This information service is frequently of value to exporters, who have the problem of supplying goods to a distant purchaser in accordance with standards of material or dimension originating in a foreign country.

A series of bulletins is now being issued, giving a fairly comprehensive picture of the work of standardization within individual companies, and this will be of constant value for reference by company executives, heads of standards departments, consulting engineers, and firms considering the inauguration of standardization work.

There has been a marked increase in interest on the part of industrial executives, in regard to the standardization movement, and it is more and more recognized by management that standardization has an important part to play in the improvement of the processes of industry, in broadening its markets and in reducing costs of production.

The membership of the A.E.S.C. now consists of 19 national trade associations, 9 national technical societies, and 7 government departments. Charles E. Skinner, assistant director of engineering of the Westinghouse Electric and Manufacturing Company, is chairman of the committee, and Charles Rufus Harte, construction engineer of the Connecticut Company, is vice-chairman. Its advisory committee of industrial executives is composed of: J. A. Farrell, president, U. S. Steel Corporation; George B. Cortelyou, president, Consolidated Gas Company of New York; J. W. Lieb, vice-president, New York Edison Company; L. F. Loree, president, The Delaware and Hudson Company; Gerard Swope, president, General Electric Company.

Copies of the yearbook may be had upon application to the office of the American Engineering Standards Committee, 29 West 39th Street, New York.

A Mud Ranch House Designed by a California Engineer

By R. M. Gray
Mem. A.S.A.E. Engineer, Table Mountain Ranch, Oroville, California

FOLLOWING up the very interesting issue of AGRICULTURAL ENGINEERING for April, a description of the house on one of our ranches may be of interest.

This building was designed and constructed by J. M. Howells of San Francisco, consulting engineer for the Great Western Power Company and originator of the hydraulic fill method of dam construction, who, at the time of construction, owned the property on which it is situated.

The exterior walls are of earth of a red-tinted mixture of clay and loam, the particular material being selected after making many tests of soils available including black adobe, the tests being for carrying capacity, drying without checking and cracking and weather resisting.

The concrete basement of a residence previously burned was used as the lower portion of the first or ground floor. The mud walls are set back three feet from the edge of the concrete to give sufficient footing to carry the superimposed load. The walls of the lower and upper floors are 18 and 12 inches in thickness, respectively, the 6-inch offset being used to carry the floor joist. Forms were built in raises of 6 inches at a time into which the dry earth was spread and thoroughly mixed with water to saturation. Each 6-inch layer was given sufficient time to become partially dried out or cured before another was added.

The window openings are narrow to decrease summer heat penetration and flare outward on the interior side to assist in spreading the light throughout the room.

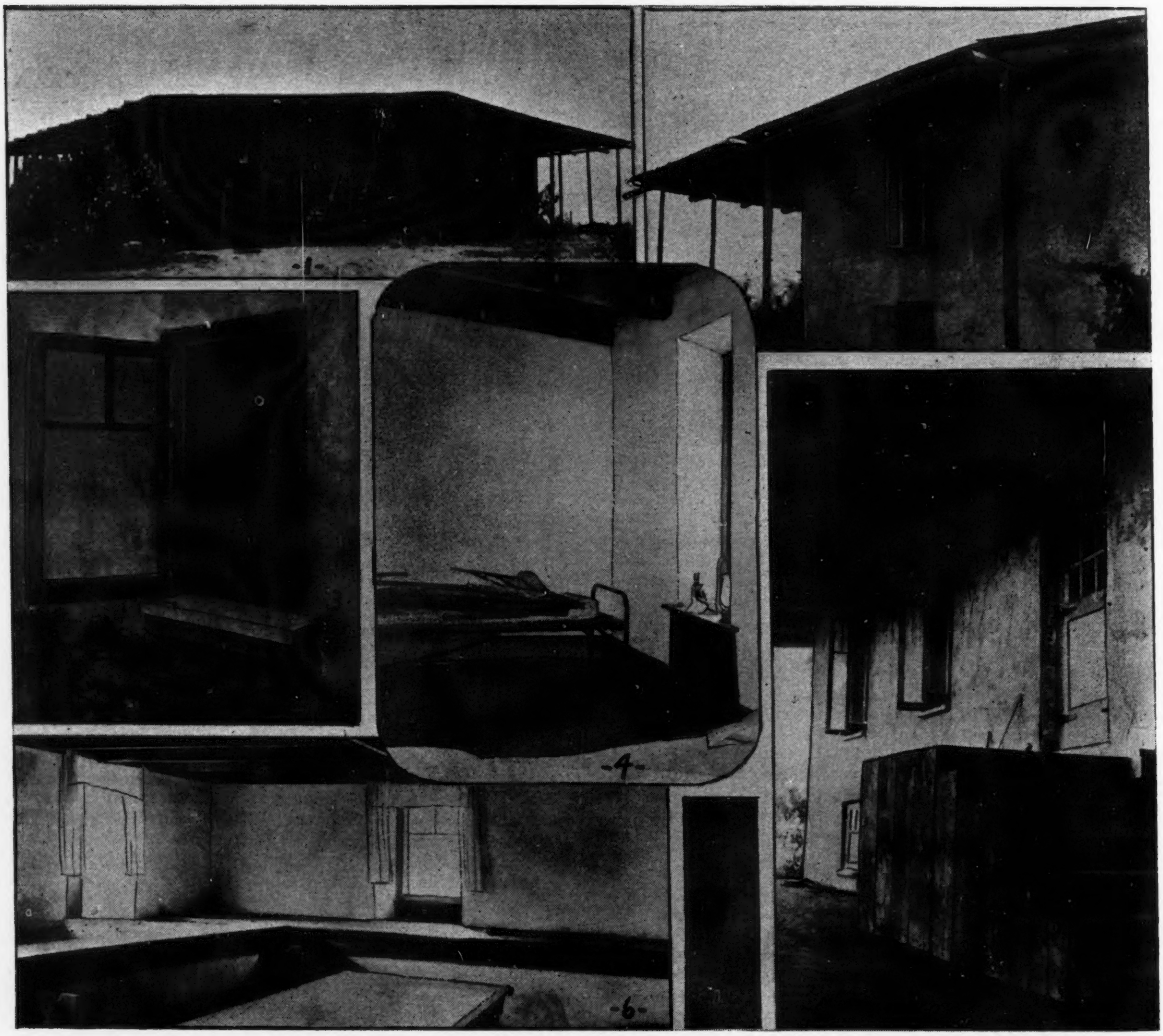
The roof was designed to carry an earth and sod covering but this plan has not been carried out as yet.

The exterior is stucco, rough trowel finished, which is held in place by common wire fastened to the walls with wire nails. The interior is plastered directly on the earth walls with interior walls of frame and plaster.

The building was constructed in 1922 and at present looks to be in perfect condition, only one slight crack having appeared in the interior plaster.

The type of construction lends itself to conditions existing in the Sacramento Valley particularly due to its giving a very cool building during summer months.

I cannot give any figures as to cost of construction, but I know it would compare favorably with that of a like building of conventional type.



Six views of the "mud" house on Liberty Ranch, near Oroville, California. (1) The house itself. (2) Northwest corner of the house. (3) Ground floor window. (4) Corner of upper floor room. (5) Front entrance (temporary steps). (6) Interior of room on the ground floor

How Agricultural Engineers Promote More Efficient Agriculture Through Explosives

AN OBJECT lesson in the distribution and more efficient use of explosives as an important factor contributing to reducing the waste and increasing the efficiency in agricultural field operations, and one of the outstanding features of the twentieth annual meeting of the American Society of Agricultural Engineers held at Lake Tahoe, California, in June, was the conference of members of the land clearing group of the Reclamation Division of the Society held during the first day of the meeting. The purpose of the meeting was primarily to enable the men engaged in the distribution of pyrotol, the surplus war explosive being salvaged by the federal government, to get together to discuss their mutual problems and also new developments in land clearing engineering.

One or more representatives were present from twelve states. S. H. McCrory, chief of the division of agricultural engineering, Bureau of Public Road, U. S. Department of Agriculture, presided at the meeting.

The program of the conference was opened by the presentation of a paper by L. F. Livingston, specialist in agricultural engineering of the Michigan State College, dealing with various problems met with in distributing pyrotol to farmers for agricultural blasting. In the scheme of distribution adopted by many states, the county agent pools the orders of individual farmers and, when he secures enough for a carload, forwards the order to the state agricultural extension service. Under this plan the county agent is the key man, and unless he is thoroughly convinced of the benefits which the farmers of his county can and should obtain from this work, very little can be accomplished. In counties where the county agent is indifferent or in counties where there is no county agent, it is difficult to reach farmers who use pyrotol. Mr. Livingston recommended that, in counties where there is no county agent, the distribution be made through a local agency, such as bank, elevator, farmers' cooperative enterprise, or an explosives dealer. Under this arrangement such an agency agrees to handle the distribution of the explosive without profit, but is allowed a small sum, not exceeding $50.00 per car, for actual expenses.

Where the county agent is indifferent to pyrotol distribution Mr. Livingston suggested that special pains be taken to secure publicity in that county to advise the farmers that pyrotol is available for them, through such means as news articles sent direct to the county newspapers and the holding of field demonstrations in adjoining counties. Happily, where a cooperator has once been secured, as when an indifferent county agent has been converted, the benefits to all concerned are so evident that it is never necessary to repeat the treatment.

One of the most interesting topics presented and discussed was that of the campaign now being carried on in Wisconsin to teach the farmers safe methods of using explosives. This was presented by John Swenehart and W. A. Rowlands, professor and assistant professor of agricultural engineering, respectively, of the University of Wisconsin.

In this effort a truck tour which will reach every county in the state has been started. The truck has been covered with striking instructive placards, and the speaker emphasizes the fact that the danger connected with explosives does not lie in the explosive but in the man who uses it. The right method used at the right time always gives the right results. The county agent arranges meetings on the roadside, in villages, in school yards, or in fields where the recommended methods can be demonstrated. Usually four meetings are held per day but as many as nine have been held in one day. Over five thousand people have attended these meetings so far and less than half the state has been covered.

An interesting paper, entitled "Stone Removal as a Phase of Land Clearing," was presented by A. J. Schwantes, assistant professor of agricultural engineering of the University of Minnesota. In many parts of the country there are so many boulders as to render cultivation difficult; in fact, one boulder in a field is too many. The smaller stones are generally removed by rolling or lifting them onto sleds or wagons, while the larger ones must be broken up with explosives so that they can be handled by one or two men. The stones are disposed of by piling, by dumping in ravines, or by burying them in the ground. Mr. Schwantes' investigations showed that a large hole, say, twelve to fifteen feet deep and thirty to forty feet across, was cheaper to construct than an equal area of shallow trench. No definite recommendations were given as to the depth of burial required to prevent future trouble, but the consensus of opinion in the discussion which followed the reading of Mr. Schwantes' paper was that it is necessary to bury them only deep enough to insure that they are out of the way of the plow, irrespective of the depth to which the ground might freeze.

Among the efforts to arouse interest in the more extensive use of explosives for reclamation purposes, the organization of blasting contests offers some very interesting possibilities. At this conference, R. N. Miller, of the State College of Washington, described the blasting contests which were held in that state last winter. In this case various community contests were first held, and the winners of these contests met in a countywide contest later. The contestants were graded on the methods used, time required, the amount of powder used, and the results secured. These contests were very suc-

(Left) In blasting this rock with pyrotol it was thrown out and split up so that even the largest pieces could be handled by one man. (Right) An exhibit truck stressing safety with explosives that is being used with unusual success in Wisconsin

(Left) Explosives are necessary to remove these stumps and to increase the productiveness of this field. (Right) A pyrotol demonstration for farmers. Note stump in foreground shattered by the explosive

cessful as a publicity stunt. The interest and attendance at all of them were most gratifying. They also presented object lessons to strengthen points made by the pyrotol specialists, who gave a demonstration of efficient and safe methods of blasting. The discussion brought out the fact that each contestant must be watched to insure that he does not use any method which might possibly be dangerous.

The land clearing conference held at Lake Tahoe is the second one of its kind to be held in connection with the annual meeting of the American Society of Agricultural Engineers, and it is planned to continue these conferences as a regular event each year in connection with the Society's annual meeting. So great is the importance of this field of agricultural engineering activities and so intense has been the interest in these conferences that at the annual meeting in June 1927 a whole day's program is being arranged for the land clearing group. An important feature of this program will be discussions relation to proper use of explosives.

The Agricultural Engineer Holds the Key to the Agricultural Situation

By Arthur Huntington

Mem. A.S.A.E. Public Relations Engineer, Iowa Railway and Light Corporation

AMERICA has never righted its wrongs by dragging the fortunate down to the level of the unfortunate but by elevating the unfortunate to the level of the fortunate.

It was the lifting of the farmer to the basis of the city man that cured the troubles following the Civil War, and that lifting was accomplished by the use of better equipment, by utilizing the services of the engineer.

It was not economy, or finance, or rate legislation that solved that problem, but rather the self-binder, the gang plow, the power thresher, and many other equally important tools on the farm; and the refrigerator which made cold storage, cheap transportation, and better methods of processing and marketing the products of the farm to the city man that gave the farmer economic independence.

Stated in terms of corn production, at the outbreak of the Civil War it took 58 man-hours per year to produce an acre of corn. The better equipment of the nineties reduced this to about 25 man-hours, and in 1920 it was about 17 hours.

Or, in terms of egg production, prior to the advent of cold storage, eggs were available only for local consumption through local markets. Today the packing and marketing of eggs through cold storage is the source of income to the farmer almost as great as the dairy industry, which was also a product of refrigeration.

It was the American engineer cooperating with inventive genius that rescued agriculture after the Civil War. It will be the American engineer operating through the public utilities and their allied agents that will place him on an equal footing with industry at this time.

The farmer has not retrograded; he has not progressed as rapidly as the city man. He is continuing to do by hand or animal power those things that must be done by mechanical power if he is to keep pace with industry. He must use labor-saving machinery to produce products to exchange for the automatic machine-made products of the city man.

This cheap power and automatic machinery must come through the engineer either directly or indirectly. And why shouldn't the engineer be the agency of this reclaiming of agriculture? He gave to the factory man the means that gave him the advantage over agriculture. It was the engineer that made it possible to operate a factory of any size at a power cost that is only a fraction of the cost of the best equipped plants of twenty years ago when the basis of agricultural and industrial exchange was equal.

It was the utilities and the engineer that gave to industry the individual automatic motor, efficient light, communication through both the telephone and radio, cheap transportation, and many other advantages. The farmer has availed himself of all these advantages to a small extent but nowhere near the extent that will make him the equal as a producer of the man of industry.

Of late years we have heard much of the farmer's trouble of having to pay too much for what he purchases, of not getting enough for his product. We have heard his appeal to the banker, to the politician, to his leaders to organize; we have heard of his dissatisfaction regarding prices; but not once has he sought the help of the person who solved his problems after the Civil War, the engineer; but the engineer is going to the farmer.

The machinery of progress is already in motion. The American Society of Agricultural Engineers is at work. The electrical and mechanical men are approaching the farmers' problems from their point of view. The chemical engineers and the economists and accountants operating along with engineering principles are making their contributions, until today the farmer has again started to take a slice off of his production costs by increasing the output per worker by the use of power under the direction of the engineer.

We as engineers have contributed much to agriculture in the past but we are not through. We must again place it on an equal footing with industry and let us hope that with the firm establishment of the American Society of Agricultural Engineers that there will never again be a lagging of agriculture behind industry and that in the future we will so firmly establish ourselves in the heart of agriculture that our preeminence will never again be questioned.

Research in Agricultural Engineering

A department conducted by the Research Committee of the American Society of Agricultural Engineers

Research in Agricultural Engineering, 1925*

By R. W. Trullinger

Mem. A.S.A.E. Specialist in Agricultural Engineering, Office of Experiment Stations, U. S. Department of Agriculture

RESEARCH and investigation in agricultural engineering showed substantial progress during 1925. In this report it will be possible to draw attention only to typical outstanding instances of such work and to review briefly the more important results. The purpose is to indicate the type of work which was done during the year, to show something of its scope, and to draw attention by inference to what appear to be important lines of inquiry requiring further consideration.

MACHINERY

Considerable work has been in progress dealing with the evolution of the principles governing new methods and machines to perform agricultural operations previously done inefficiently or not at all. Other work deals with the further development and perfection of methods and machines which actually perform certain operations, with the idea of increasing their efficiency. While much of this work is still of a local character, some of it has reached the point at which the development of new and broadly applicable fundamental principles is necessary for further progress.

Traction machinery. A problem of broad significance is that relating to the development of traction machinery for use specifically in farming operations. The extremely severe conditions imposed by some farming operations in certain localities have been found to result in rapid and costly depreciation in traction machinery not specifically adapted thereto. This has resulted in quite determined efforts at the better adaptation of tractors to the severe conditions of mechanical farming.

Air Cleaning. The California station, for instance, has found, in a continuation of its studies of the removal of dust from tractor engine intakes, that at least 90 per cent of the dust normally inspired by any air cleaner or carburetor can be avoided if the intake is placed high and faced away from the direction of motion of the tractor. A rearward opening acts as an inertia type dust separator. It has been further found that in a service test involving several uncontrollable variables, no just comparisons can be drawn among air cleaners not differing greatly in efficiency.

Tractor Engine Lubrication. Lubrication of traction machinery and of power engines to economically meet the conditions imposed by farming operations has also developed into an important feature of the traction machinery problem. The California station has found that frequent changing of crankcase oil and consequent maintenance of higher viscosity markedly reduces engine wear.

Experiments at MacDonald College in Quebec on the effect of fuel dilution on lubrication of tractor engines have shown that a close relationship exists between the mechanical condition of the engine and the rate of dilution. Where compression was poor there was a much heavier fuel consumption, accompanied by heavy dilution. Where compression was good the percentage of dilution was much smaller. In all the engines tested, however, the dilution resulting from the burning of kerosene was much heavier than any engine could bear and still maintain its lubricating value. The conclusion was drawn that the average kerosene burning tractor suffers from lack of lubrication about half of the time during which it works, and that the use of kerosene in any but "fresh oil" types of engines should be advised against.

*Paper presented at the 20th annual meeting of the American Society of Agricultural Engineers, at Lake Tahoe, California, June, 1926.

Tests at the University of Utah on the degree of crankcase oil dilution beyond which it is safe to run an engine bearing indicated, on the other hand, that dilution up to 50 per cent has no bad effect upon the engine as regards increased friction and temperature of the bearings so long as a film of oil can be maintained between the surfaces, although the dilution may be injurious from other standpoints. When this film breaks down, both friction and temperature increase. The tests indicated that the film does not break down until the oil becomes highly diluted if the pressure is low. When the pressure is increased the diluted oil seems to be squeezed out from between the surfaces more easily. In the case of light oils the film breaks down more easily than in the case of heavy oils. In starting with a dry bearing, considerable time is necessary for the establishment of the film between the two surfaces, but when the film is once established conditions remain constant. The conclusion was drawn that the tendency to attribute burned out bearings and scored cylinders to oil dilution is not always fully justifiable.

Data from other sources showed that a complete journal bearing can be considered as an oil pump, in which the pressure developed is utilized to support the imposed load and to induce a flow of oil through the bearing. Oil feed pressure was found to increase proportionately the total flow through a bearing, and the rate of heat generation increases approximately as the square of the speed and as some power less than the first of the oil flow.

Further experiments by a private research institution showed that corrosion in internal-combustion engines is generally due to sulphuric acid formed by the combination of sulphur carried in low grade fuels and oils with water that enters into or is generated in the engine. Much of this trouble occurs in winter and is traced directly to the action of water that condenses on the inside of the cylinders and crankcase when a cold engine is started. The only successful method found of dealing with this problem was to provide a lubricating system that begins to function as soon as the engine is started. The splash system met this requirement best. The tests did not confirm the assumption that the use of thin or diluted oils results in the rapid wear of pistons and cylinders. A castor oil film was found to be more resistant to the action of water than a mineral oil film.

Tests of the effect upon crankcase oil dilution of high cylinder wall temperatures showed that a sharp reduction in dilution occurred as the boiling temperature was reached.

Engine Operation. Engine starting tests at the U. S. Bureau of Standards showed that within certain limits richness of the fuel mixture determines the number of engine revolutions necessary before an explosion occurs. Richness of the mixture in the cylinder rather than that of the mixture leaving the carburetor was found to be the deciding factor. An advance of approximately 35 degrees in the spark gave a much shorter starting time than one of 10 degrees, and somewhat shorter than one of 50 or 80 degrees. Retarding the spark beyond top center gave even poorer results. For starting in cold weather, choking was found to give somewhat better results than throttling as it reduced the pressure throughout the intake system instead of in the manifold alone.

Carbon formation studies showed that carbon deposits in internal-combustion engines arise from thermal decomposition and oxidation of lubricating oil. Factors that influence the rate of carbon deposition are those which affect the quantity and character of the lubricating oil that reaches the combustion chamber and its rate of breakdown in that chamber.

An increase in carbon deposition was found to increase the indicated thermal efficiency of an engine, the gain in efficiency being proportional to the increase in carbon deposit. Further data indicated that the completeness of combustion of the engine fuel as such has very little influence on carbon formation. Carbon removal efforts directed at the influencing of completeness of combustion are considered to be misguided except as to the effect of obtaining a higher temperature in the combustion chamber.

Engine Fuels. Experiments by a private organization on the use of alcohol made from cane molasses and alcohol-ether fuels in tractors, automobiles, and stationary engines showed that alcohol can be used more successfully in tractors and other engines running at almost constant speeds than in automobile engines. A mixture of alcohol with 0.5 per cent of pyridine and 1 per cent of gasoline or kerosene was found to give satisfactory results over considerable periods of time in a number of different types of tractors, motor trucks, and stationary engines. In no case was there corrosion of the engine parts and in all cases the cylinders were especially free from carbon. By proper manipulation the excess of alcohol used over other fuels in tractors was about 33.3 per cent. A slight advance of the ignition proved advantageous, and no air preheating device was necessary. The addition of ether to the alcohol was found to improve it as a fuel for engines operating under variable speed and power conditions. Such a mixture carbureted readily even at low temperatures, and no difficulty was experienced in starting the engine when cold. It was possible to maintain cylinder lubrication when burning alcohol-ether mixtures by adding lubricating oil to the fuel at the rate of about 1 per cent by volume.

Traction. It is being found that many tractors, as at present designed, are inefficient for farm use owing to their mechanical incapability of meeting the traction conditions of agricultural soils. It has been found by the Alabama station, for instance, that the tractive efficiency of a tractor is influenced by its total weight, distribution of its weight, and the power of its engine as well as by its drivewheel equipment. It has also been found that the principles governing traction in soils are definitely related to their engineering properties and the manner in which stresses are distributed in and resisted by them. In this connection a method has been developed of determining the distribution and value of tractive impulse stresses in soils as delivered by the lug of a tractor drivewheel.

German experiments indicated that the proper design of drivewheel equipment, and especially of the lugs of tractors, is dependent chiefly upon the soil conditions. The rather generally indicative nature of the results obtained by comparative tests of different lug equipment is shown by the finding that cross lugs gave better results than spiral lugs on heavy, sticky stubble soil. Narrow slots in the wheel rim were useless and wide slots assured traction, but with a great waste of power. Side extensions of lugs gave good results, but broad wheel rims with small lugs gave almost as good results. Naturally such experiments do not reveal the cause of the results obtained, and are apparently inadequate, therefore, to provide a basis for accurate manipulation.

Soil Dynamics and Tillage. It is being recognized that the production of a desired degree of tilth in a soil by any tool, regardless of its shape, size, or speed of operation, is governed largely by certain soil properties and certain physical laws. Draft tests of plows and cultivating tools give results which are apparently only very generally indicative of these properties and laws.

Plow Draft. The Nebraska station found, for instance, that at low compactions of the soil, the variations in soil moisture content had very little influence on plow draft. At higher compactions the draft decreased slightly with each increase in moisture content up to about 17 per cent and then increased slightly.

The Missouri station found that heavy manuring of silt loam soil seemed to increase the draft of plows slightly. Chemical fertilizers, even in heavy applications, did not increase the draft. Within a range of moisture conditions satisfactory for plowing, there was a tendency for the draft to increase as the moisture content decreased.

Plow draft experiments on different soil types at the Illinois station indicated that the draft varies with different soil treatments, and that the addition of organic matter to a soil tends to reduce the power required for plowing.

The Cambridge School of Agriculture in England showed that the state of consolidation resulting from the nature and treatment of the previous crop has a most marked influence on plowing draft, causing variations of from 107 to 580 pounds in gross draft and of from 66 to 483 pounds in net draft on a typical two-horse soil. The relation between draft and depth of furrow was found to be linear, the net draft per square inch tending to increase with increasing depth, except when the previous crop was a root crop, when a decrease at depths greater than from 6 to 8 inches was noticeable. The relation between draft and width of furrow was also linear, the net draft per sqaure inch increasing in some cases and in others decreasing with increasing width. Further observations suggested that a greater proportion of the net draft is used in overcoming the resistance of the soil than in turning the furrow. The quantity of moisture in the soil had a considerable effect on draft, there being indications of an optimum content from which an increase or a decrease will result in increased draft.

Studies at the Rothamsted Experimental Station in England showed that quite small variations of the drawbar pull in plowing correspond to actual variations in the resistance of the soil, and that chance changes in the implemental factors will not produce large effects. The slope of the land is without appreciable effect up to a gradient of 1 to 40. Dynamometer tests showed large variations in the soil of a single field over short distances which were correlated with the clay content.

These and other tests have emphasized the fact that the development of tillage machinery cannot advance much further until a knowledge of some of the fundamental soil factors involved is obtained. Such knowledge should (1) elucidate and evaluate the properties of soils which govern the production of desired degrees or states of tilth in soils and (2) evolve and develop the physical and mechanical principles governing the design of tillage implements which will specifically meet the conditions imposed by the engineering properties of soils and will satisfactorily produce desired states of tilth with a minimum utilization of power and labor.

The work in progress at the Alabama station along this line is quite well known. Studies at the Rothamsted Experimental Station on the principles of cohesion in soils have shown that a general qualitative relationship apparently exists between the results of laboratory experiments on the cohesion of puddled soil and those of field measurements of cohesion. The results of preliminary experiments on surface friction between metal and a light sandy soil and a heavy loam as they were gradually dried showed that both soils gave a practically constant friction for a range of moisture content from 0 to 12 per cent. At this point the soils began to wet the metal, and an increase in friction resulted. This increase reached a maximum at about 17 per cent moisture content in the light sandy soil. Beyond that point the metal surface was wetted so freely as to be lubricated by the water film, and the friction decreased. This continued until the soil was too fluid to bear the weight of the metal slider. These results appear to bear out the Alabama results.

The heavy soil showed two maxima in the friction instead of only one. These corresponded to the two different ways in which the soil wet the metal surface, namely, wetting with and without sticking. In the one case the water in the larger soil capillaries wets the metal surface but the soil itself is firm and coherent, so that the metal slides without being contaminated by the soil to an appreciable extent. Shrinkage measurements of this soil showed that its pores were just full of water at about 19 per cent, so that the wetting began a little before this stage was reached and extended considerably beyond it. Later the wetting became so as to produce a lubricating effect. The beginning of the second increase in friction corresponded to the point at which the soil began to stick to the metal. This corresponded to a definite stage of water saturation of the clay in the soil, and true surface friction ceased at this point, since the slippage took place within the top layers of the soil itself. The governing factor was then the plasticity. These results, which again appear to largely bear out the Alabama experiments, were taken to indicate that, over a moisture range suitable for plowing, the cohesion

increases when the friction decreases, and that the choice of an optimum plowing moisture should therefore consider two opposite effects.

Further studies by the Rothamstead Experimental Station indicated that the attainment of high values of capillary cohesion in a soil depends upon a small value for the size of the soil particles. For any given particle size the cohesion has the same order of magnitude at all moisture contents. The predominating influence is the soil texture, i.e., it is the number of water films present which matters rather than their radius of curvature as such. The conclusion was drawn that the value of the internal friction of a soil falls with increasing fineness of the particles. The effect would appear to be strictly analogous to the decrease in friction between two surfaces when the rough places are removed by polishing.

Studies at the American Robert College, Constantinople, showed that the cohesion of clay is due to two factors. The first of these is the pressure exerted by the surface tension of the capillary water, the intensity of which exceeds all other forces in soils. The second factor consists in the fact that the properties of the water contained in voids of a width less than 0.0001 millimeter are not identical with those of ordinary water. In such voids viscosity and surface tension are increased in inverse proportion to the diameter of the voids and the water loses its ability to evaporate. Thus the capillary water of the clays is, to a certain degree, solidified by the influence of the forces exerted by the molecules of the solid matter. Due to this fact the capillary pressure assumes far greater values than it would if the surface tension of the capillary water had is normal value.

Further studies showed that the modulus of elasticity of clay in compression has a constant ratio to the capillary pressure. Capillary pressure was found to play the same part in the physics of clays as does intrinsic pressure in the physics of solids. The elastic properties of the clays are therefore qualitatively identical with those of granular solids. It was also found that no essential difference exists between sands and clays other than those in grain size and shape. However, the volume of voids in clay may be 98 per cent of the total volume, while the volume of voids in sand is about 50 per cent at the maximum. An attempt to characterize sand and clay friction showed that friction between smooth surfaces of solid bodies is a purely physico-chemical process and is caused by direct molecular interaction. Friction between imperfectly smooth solid bodies involves not only these factors but also a file-like action. These results also appear to bear out the Alabama experiments to a considerable degree.

It is quite evident, however, that, while these studies are plainly elucidating the soil factors involved in tillage, they have not as yet fully bridged the gap between cause and actual effect on the design of tillage machinery. French experiments led to the conclusion that the shape of a plow moldboard rather than the composition of the metal surface is the governing factor in draft. However, it has remained for the Alabama station to proceed on the basis of the molecular interaction theory of friction. While that station is apparently not quite ready to make public the details of the results obtained, enough has been published to suggest that the adhesion of soil to plow metal and the consequent frictional resistance in draft are due to the fact that the two materials are brought into such close contact as to permit the molecules of one to attract those of the other. Some indications have been obtained that appropriate treatments of metals of known composition tend to retard such molecular interaction and therefore materially affect the adhesion.

Miscellaneous Machinery. Much work has been in progress on other types of field and belt-driven machines. Apparently a number of research institutions are dissatisfied with existing methods and machines for performing certain agricultural operations, not only from the standpoint of adequacy of performance but from the standpoint of power required.

Seedbed Preparation. For instance, German experiments on tillage for spring seeding showed that scarified soil retained winter moisture better than plowed soil. Seed drills with ordinary drill shares worked irregularly in very loose soil, and the seed did not have the proper contact with the soil particles. Rolling of scarified soil resulted in a better structure for this purpose. Rolling of seeded rows resulted in a more dense soil structure and in a higher water retaining capacity of the row soil than of that between the rows.

Seeding Machinery. The California station found that, with the same setting of the seeding indicator on several types of grain drills, the amount of seed in the hopper did not affect the rate of seed delivery until the seed shells were exposed. Neither the operation or nonoperation of the agitator nor variations between ordinary high or low field speeds had any effect on the rate of seeding. Considerable variation was found in the rate of seeding of different varieties of wheat. The treating of wheat with copper carbonate dust caused the rate of seeding to decrease from 5 to 7 per cent, depending upon the variety and quality of the seed. Large plump varieties gave the largest decrease in rate of seeding when treated with copper carbonate dust, especially when planted at low rates per acre.

Fertilizer Distribution Methods and Machinery. The Iowa station found that fertilizer applications located in direct contact with seed in the hill or in the drill row are likely to retard germination. Various factors such as rainfall, soil type, kind of seed, and kind of fertilizer were found to modify the injury produced. Very small amounts of concentrated, soluble chemical fertilizers were injurious and these amounts were often smaller than the rates for which the fertilizer attachments upon available seeding machines could be adjusted for. Small fertilizer applications retarded germination and large applications inhibited it. It was concluded, therefore, that for the best germination of all seed under all conditions of climate and soil, the distribution of fertilizers in direct contact with the seed either in the hill or row is not advisable, and that planters with fertilizer attachments which will cause such direct contact should be redesigned.

Other methods of localized distribution of fertilizers such as above, below, or at the sides of the hill or drill row were found to be more promising. The side method was found to be the best for all crops sown in hills or rows with wide intervals between.

Further studies at the Iowa station resulted in the recommendation that a combination fertilizer-grain drill be used in fertilizing cereals like oats and wheat. Moderate applications of noncaustic fertilizers were found to give the most economical returns by this direct-contact-in-the-seed-rows method. However, larger applications of these or of fertilizers containing caustic ingredients like cyanamid should be made separately from the seeding. Where broadcast applications of fertilizers were made with a lime spreader upon the seed bed surface, the best results were secured when the fertilizer was worked into the soil by thorough disking.

In the fertilization of corn the hill methods appeared equal to or even superior to the broadcast methods if the fertilizer was not in direct contact with the seed. The sides-of-hill method was found preferable to the rear-of-hill method.

Disk Harrows. Studies at the California station on the dynamics of the disk harrow showed that by the proper arrangement of gangs it is possible to obtain a disk harrow which tills a strip of land, the center of which is offset from the center of the tractor as is required in orchard cultivation. Such a harrow, while operating off center, does so without side draft upon either the harrow or the tractor. Only one position behind the tractor was found where a given disk harrow operating under specific conditions of gang arrangement, weight, speed, and soil, can do so without side draft. It was also possible to design a disk harrow in which the gang arrangement can be adapted to operation, without side draft, either directly behind the tractor or with a large right or left hand offset.

Draft of Wagons. The Missouri station found that the drafts in pounds per ton of load of various kinds of equipment with different heights of wheels and widths of tires averaged the greatest for a corn stalk field, followed in order by muddy clay road, spongy clay road, blue grass sod, burned clay or ballast dry well packed cinders, dry and firm clay road, dry packed macadam, dry well packed gravel road, worn brick, concrete in good condition, and new bricks. Tests in cultivated land showed a saving in draft per ton of load by increasing the height of the wheels and the width of tires. The wagon with high wheels and narrow tires had about the same draft as the common low wheel, wide tire wagon. The

convenience of the low wheel wagon was taken to indicate its desirability for farm use. Neither the wheel height nor the tire width markedly influenced the draft on hard surfaced roads.

Silo Fillers. In a continuation of silo filler studies, the Wisconsin station found that a formula can be established which will indicate the maximum capacity of silage cutters with reasonable accuracy. Silage cutters were found to have much greater capacities than is ordinarily considered. Machines with 18 or 20-inch cylinders were found to have much more capacity than any ordinary crew of men can supply. This was taken to indicate that larger machines are unnecessary, and that machines of these sizes can be operated at speeds approximately 40 per cent slower than at present recommended and still have sufficient capacity for ordinary requirements.

Threshers and Harvesters. Studies of the efficiency of grain separators by the Illinois station showed that man labor is used more efficiently with basket racks and with small threshing rigs. Blanket tests on twenty machines showed that the grain loss could be reduced below one per cent by proper machine adjustment and better feeding except where the loss was caused by damp grain.

The Utah station found that the losses from twelve harvester-threshers were surprisingly low. In most cases the loss from headers equaled that from combines, and in addition the stationary thresher gave a loss of about 1.75 per cent.

The Illinois station found that the loss of soy beans in harvesting and threshing varied from 15 to 45 per cent, depending upon the method used and the condition of the beans.

The California station developed a thresher for single heads of grain for laboratory use in plant breeding work in which the threshing cylinder is directly mounted on the motor shaft. The fact that no toothed concave is used enables higher tooth tip speeds without cracking the grain. Sloping bars are inserted in the housing to prevent any possibility of whole heads being blown by without being hit by the cylinder teeth. The threshing cylinder and its teeth constitute the only blower, and the blast is entirely adequate to remove the chaff.

The Washington station found that static electricity in stationary threshers occurs between the straw and the machine rather than between the parts of the machine, and that the problem is rather to neutralize the static in the body of the machine than to ground the machine. There appears to be some relation between static conditions and humidity, which may point to a means of controlling smut explosions.

Seed Wheat Treating Machines. Studies at the Oregon station on mechanical equipment for the treatment of seed wheat with copper carbonate dust resulted in the development of a diagonal axle machine using a barrel or steel drum for a container, fitted with a mixing board placed diametrically across the barrel, two-thirds of the way back from the door. It was found that in treating machines of this type the mixing action will cease and the grain will be held against the drum walls by centrifugal force at from 48 to 50 revolutions per minute. This maximum speed was not influenced by the amount of grain in the drum. The best speed of operation was found to be about 30 revolutions per minute. A microscopic examination of the grain at each tenth revolution showed that at 10 revolutions each grain was coated, but rather unevnely. At 40 revolutions the coating of dust was complete, smooth, and even. Any further turning merely smoothed out the coating. The conclusion was drawn that the sliding and rolling action of the grain in this type of machine is very effective in giving a quick and even distribution of dust in an adhering coat.

The California station found that the most common fault of the seed wheat treating machines used in the state is their inability to prevent the escape of dust into the air. Every batch mixer tested coated the seed satisfactorily if operated long enough. The most efficient amount of grain to use at each treatment in a batch mixer was found to be that equal in volume to from one-fourth to one-third of the volume of the mixing box. A rotary barrel type churn was found satisfactory when filled about one-fourth full and turned slowly. It was necessary for the grain to fall from end to end or from side to side of the churn in order to secure the best results. A tight box mounted on a shaft and revolved slowly by hand or mechanical power was also satisfactory. Batch mixers were found to be in general of too small capacity and to require too much labor to be satisfactory for warehouse and ranch use.

In general, it was found that the design of the interior of the continuous revolving mixers may differ quite widely, with a correspondingly wide difference in effectiveness. The results indicated that the baffles should be so placed as not to hinder the outflow of the treated grain too much, and that the height of any baffle should not exceed one-sixth of the diameter of the revolving cylinder. The speed of operation which required the most power and produced the most violent tumbling about of the grain gave the best results.

Continuous gravity type mixers were found to require less chemical than most other types. The capacity depended upon the width, breadth, and height of the vertical chute. It was necessary for the slope of the inclined baffles to be steep enough to cause the grain to fall readily and the machine to clean itself completely. Dusted grain lodged on a much steeper slope than untreated grain. When a proportioning device was used the feed of dust was found to be irregular and the coating of the grain nonuniform.

Cotton Seed Treating Machines. Studies at the Arizona station resulted in the development of a machine for treating cotton seed with sulphuric acid. It consisted essentially of an acid circulatory and storage system and a seed hopper, rotating drum, strainer, and washer constituting the seed system.

Milking Machines. French experiments with milking machines with 16 cows showed that none of the cows objected to the machine. Eleven of them were thoroughly milked, but five kept their milk either partially or wholly. In the case of the first eleven cows, 4.58 per cent of the total amount of the milk was drawn by hand stripping in the morning and 5.58 per cent in the evening. This milk contained from two to six times more fat than that obtained by means of the machine. Considering the time required for hand stripping afterward, machine milking took twice as long as milking entirely by hand. It was found that a cow keeper can easily supervise four machines. It required only three minutes to change the cow, hand strip, weigh the milk, and pour it into other receptacles. A little more milk was obtained by machine milking, followed by hand stripping than if the whole operation was carried out by hand.

Machine Lubrication. Studies at the Mellon Institute of Industrial Research on the yield value and mobility of commercial cup greases indicated that generally the harder greases with the higher yield values show a smaller tendency to flow or a lower mobility. Greases of the same grade but of different makes were found to vary greatly both in yield value and mobility, and in fact, showed a variation of physical properties.

Kitchen Machanics Up to Date

TEACHING co-eds how to handle the soldering iron as well as the curling iron seems to be one of the principal functions of P. B. Potter (Mem. A.S.A.E.), professor of agricultural engineering at Ohio State University. Prof. Potter teaches a course called "household mechanics," in which during the past six years instruction has been given to five hundred co-eds.

There was a time when the term "kitchen mechanics" was about as insulting a remark as could be made of a young woman. However, the co-eds under Prof. Potter's direction have learned that there is plenty of truth in the title and that to manage a home or kitchen properly, they must in reality be mechanics to do the job right. In this course girls have made tin cups, tin boxes, pans, and other articles of tin; repaired leaking faucets, mended electrical fixtures, threaded and fitted pipe, sharpened kitchen knives and scissors; in fact, do general repair work found in a home.

Recently under the title "Jills of All Trades" this activity of Prof. Potter was played up in full-page space in the Sunday edition of a leading newspaper.

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture

Factor Influencing Carbon Formation in Automobile Engines, J. W. Orelup and O. I. Lee (Industrial and Engineering, Chemistry, 17 (1925), No. 7, pp. 731-735, figs. 6).—Tests are reported which showed that the major factors of carbon deposition in an internal-combustion engine are the amount of lubricating oil projected into the combustion chamber, the kind of oil used, the temperature of the combustion chamber, and the extent of time the preceding factors have been in effect. The first of these is considered to be by far the greatest factor. The data obtained are taken to indicate that the completeness of combustion of the gasoline as such has very little effect in influencing carbon formation. Apparently in carbon removal efforts directed at the influencing of completeness of combustion are misguided except as to the effect of obtaining a higher temperature in the combustion chamber.

Snook O'Brien's Model Diversified Electrical Farm, J. W. Otterson (Journal Electricity, 54 (1925), No. 12, pp. 591-594, fig. 1).—A description is given of a farm in the San Joaquin Valley of California which was laid out to show, through statistics and a miniature reproduction of the hypothetical farm, the relation of the cost of electricity to the gross returns when a number of crops are being raised on one farm. It has been found that by securing this diversification a smaller installation is possible, a greater load factor is secured, and the peak demand is reduced considerably to the benefit of the central station and the consumer alike.

Drainage and Flood-Control Engineering, G. W. Pickels (New York and London: McGraw-Hill Book Co., 1925, pp. X+450, figs. 154).—This book deals with improvements of small areas of cultivable lands by underdrainage and with the reclamation of large areas of wet and overflow lands by surface drainage and by flood control. It contains chapters on precipitation, flood run-off, stream discharge measurements, flow of water in open channels, flow of water in tile drains, land drainage by open channels, soil physics, underdrainage, pumping plants for drainage districts, flood protection by channel improvement, flood protection by levees, flood prevention by reservoirs, excavating machinery, and drainage law.

Strength of Materials, A. P. Poorman (New York and London: McGraw-Hill Book Co., Inc., 1925, pp. XI+313, figs. 211).—This book is based on procedure at Purdue University, contains chapters on elastic stresses and deformations—tension and compression, ultimate stresses and deformations—tensions and compression, shearing stresses and deformations, riveted joints, shear and moment in beams, stresses in beams, deflection of cantilever and simple beams, fixed and continuous beams, beams of constant strength, beams of two materials, resilience in beams, torsion of shafts, combined stresses, Euler's, Rankine's, and straight-line column formulas, columns in general, deflection of beams by area moment method, deflection of beams by equivalent cantilever method, and curved beams and hooks.

Measurement of Cup Grease Consistency by Use of the Plastometer, P. K. Porter and W. A. Cruse (Industrial and Engineering Chemistry, 17 (1925), No. 9, pp. 953-955, figs. 3).—Studies conducted at the Mellon Institute of Industrial Research on the yield value and mobility of three series of commercial cup greases by the use of a modified Bingham plastometer are reported. A rational comparison of the various grades and makes of cup greases is thus shown. The curves obtained by platting rate of flow against pressure resemble closely those obtained by other investigators for such typically plastic substances as paints.

The data indicate that generally the harder greases with the higher yield values show a smaller tendency to flow or a lower mobility. Greases of the same grade but of different makes were found to vary greatly both in yield value and mobility, and, in fact, showed a variation of physical properties. It is stated that yield value and mobility taken together are related to the lubricating value of the grease only in that they express the characteristics of the grease in a more rational manner than do the methods obtained by the empirical methods of testing so far proposed.

Investigations of Small Refrigerating Apparatus, W. Redenbacher (Technik Landw., 5 (1924), No. 10, pp. 202, 203, figs. 3).—Investigations of the efficiency of small refrigerating apparatus, especially for dairy purposes, are briefly reported. It was found useful to mount the motor, the compressor, and the refrigerator as a unit and to transmit power through housed gears to prevent the entrance of moisture. The importance of constructing the refrigerator proper of waterproof insulating materials was also indicated. It was found that the entrance of moisture not only destroyed the insulating materials and the wood, but also reduced the insulating action.

Relation of Depth to Curvature of Channels, H. C. Ripley (American Society Civil Engineering Proceedings, 51 (1925), No. 10, [pt. 3], pp. 1907-1938, figs. 10).—The results of investigations into the law of channel hydraulics are reported. From these results two empirical formulas were devised, by means of which the cross-profile of a channel may be computed. Some characteristics in the law of channel hydraulics not heretofore known were also disclosed.

The increasing curvature in bends was found to increase the depth only to a certain point. This point is reached when the radius of curvature is equal to forty times the square root of the area of the cross section. Where the channel occupies the entire waterway, and the radius of curvature exceeds about fifty times the square root of the area of the cross section, the cross profile may not conform strictly to that due to curvature. Hence, the efficiency of the derived formula to reproduce results is restricted to those channels having a radius of curvatures not exceeding this amount.

It appears, therefore, that in channels occuping the entire waterway, any curvature greater than that due to a radius of curvature equal to forty times the square root of the cross sectional area is ineffective in producing increased depths, and any curvature less than that due to a radius of curvatures equal to about fifty times the sqaure root of the cross sectional area may have irregularities which cannot be reproduced. A single curved jetty will produce a deeper channel than two parallel jetties of the same curvature.

Some practical applications of the formulas are given.

A Thermodynamic Analysis of Gas Engine Tests, C. Z. Rosecrans and G. T. Felbeck (Illinois University Engineering Experiment Station Bulletin 150 (1925), pp. 95, figs. 27).—An investigation to apply a rational thermodynamic analysis of the constant volume cycle to test results obtained from an engine operating on such a cycle and, from a comparison of results of experiments, to determine the factors which prevent the actual engine from attaining the ideal performance is reported.

A method was developed for calculating the ideal adiabatic Otto cycle, which gives results differing from the actual cycle by amounts which can be accounted for by the various engine losses. A method was also developed for estimating the progress of the explosive reaction during the expansion stroke and for determining the time at which the reaction is practically complete.

The thermal efficiency of the engine tested at first increased with increasing air-gas ratios, finally attaining a maximum, and then decreased as the air-gas ratio increased. The thermal efficiency also increased rapidly at first with increasing compression ratio and tended to reach a maximum value at a compression ratio of about 6 to 1. When the compression ratio was increased beyond this point, the thermal efficiency decreased and the operation of the engine became irregular.

The curves of ideal thermal efficiency and indicated thermal efficiency obtained were of the same shape and were practically parallel, substantiating the accuracy of the theoretical analysis of the cycle. The effect of dissociation with the particular fuel used was found to be very slight, and the dissociation at the calculated maximum temperature in most cases was zero. The theoretical analysis gave results which agreed very well with the air-standard efficiencies when the cycle was based on the operation of pure dry air.

The effect of different fuels on the thermal efficiencies was found to be slight. It was definitely established that the reaction in the cylinder is not complete at the instant when maximum pressure and temperature are attained. The continuation of the reaction occurring late in the stroke is sometimes caused by slow combustion, and sometimes by the fact that the gas in the valve pockets and other outlying parts in the combustion space is not ignited until late in the stroke.

The general tendency of the reaction velocity was to decrease with weaker fuel mixtures. No definite effect of compression ratio on reaction velocity was evident. The heat loss during compression, explosion, and expansion was found to decrease rapidly with increasing air-gas ratios, due to the lower gas temperatures attained with the weaker mixtures. Compression ratio had less effect on the heat loss from the gas than did the mixture ratio.

The Fallacy of the Test for Lactose Fermenters as an Indicator of Faecal Pollution of Waters, O. Schobl and J. Ramirez (Philippine Journal Science, 27 (1925), No. 3, pp. 317-324).—In a contribution from the Bureau of Science, Manila, studies are reported which showed that even though lactose fermenters others than true Bacillus coli are frequently present in human and animal feces, these bacteria as a group cannot be considered as an indication of fecal contamination owing to their wide distribution in nature and to their presence in places where fecal contamination is excluded. On the other hand, it is thought justifiable to consider true B. coli as an indicator of fecal pollution owing to its relatively limited distribution outside of the human and the animal body.

It is stated that true B. coli can be fairly readily differentiated from the other members of the coli group by the type of its colony on eosin-methylene-blue lactose agar plate. Comparative tests of B. coli strains failed to yield any criterion for the differentiation of B. coli of human origin from that of animal origin. Under natural conditions the pollution of water by B. coli originating

from the feces of animals such as fishes, frogs, and insects is considered unlikely.

Origin of Quenching Cracks, H. Scott (U. S. Department Commerce Bureau Standards Science Paper 513 (1925), pp. 399-444, pls. 4, figs. 15).—Studies conducted on the dimensional changes which tool steel undergoes on hardening showed that a one-inch diameter cylinder was very susceptible to cracking when quenched in oil but not when quenched in water. Presumably the stresses produced by the faster quenching are greater than in the former. Examination of the cracked specimens showed that failure was due to tensional stress at the surface. The axial stress at the surface after quenching in water was found to be compressional and high. It is concluded that hardened steel is highly resistent to compressional stress but not to tensional stress.

An experimental determination of the conditions producing cracks in a particular oil hardening steel showed that cracks are produced by permanent stress, which reaches a maximum value at ordinary temperatures. Permanent tensional stress can be produced at the surface by cooling only when the coefficient of expansion is negative and the steel is plastic.

From an analysis of the temperature distribution during quenching, expressions are derived, showing the relations between the major variables of quenching and the internal stress. These relations are in agreement with the experimental results, and suggest practical expedients for the control of internal stress. The bearing of these results on the heat treatment of high stress members of farm machinery seems evident.

An Economic Study of Methods of Harvesting Soybeans for Seed, W. F. Simpson (Journal American Society Agronomists, 17 (1925), No. 9, pp. 557-567).—Studies conducted at the Virginia experiment station on soybean harvesting methods and equipment, with special reference to waste of seed in harvesting, cleanliness of the seed saved, damage to the seed, rate of harvesting, cost of harvesting, and the factors affecting successful harvesting are reported.

The results showed that the greatest percentage of waste incurred by the cut and thresh method occurs during cutting and shocking. This loss should be less when a binder is used for cutting the crop instead of a mower. The loss next in degree of importance was found to occur during the curing period. This loss also may be expected to be lower when a binder is used for cutting and greater when a mower is used. The pea huller was found to be more desirable than the grain thresher for threshing except for small crops. The percentage of waste incurred by the row harvester was about double that incurred by the cut and thresh method. Seed saved by a row harvester must be fanned.

The costs of the several methods of saving soybean seed were found to differ but little when considering the value of the various amounts of waste. Consideration of the straw was found to depend upon the way in which the farmer can best make use of it rather than as a factor in favor of either method. The row harvester was found to be more convenient when labor is considered.

While no definite conclusions are drawn, it is considered evident that the row harvester method is considered the logical one of saving soybean seed, and that should a field harvester of a more efficient type than the modern row harvester be developed, the advantages in favor of this method of harvesting soybeans for seed would be outstanding.

Dilution Effects on Friction Coefficients and Bearing Temperatures, A. LeR. Taylor (Journal Society Automotive Engin., 18 (1926), No. 1, pp. 41-45, figs. 10).—Tests conducted at the University of Utah on the degree of crankcase oil dilution beyond which it is unsafe to run an engine bearing are reported.

In general the results of the test indicate that dilution of the crankcase oil up to 50 per cent has no bad effect upon the engine as regards increased friction and temperature of the bearings, although the dilution may be injurious from other standpoints. It appears that dilution of the oil does not affect the friction or the bearing temperature materially so long as a film of oil can be maintained between the surfaces. When this film breaks down, both friction and temperature increase. The tests indicate that the film does not break down until the oil becomes highly diluted if the pressure is low. When the pressure is increased the diluted oil seems to be squeezed out from between the surfaces more easily, so that friction and temperature are higher. It appears also that in the case of light oils the film breaks down more easily than in the case of heavy oils. It was found that in starting with a dry bearing considerable time is necessary for the establishment of the film between the two surfaces, but as soon as the film is once established conditions remain constant. The tendency to attribute burned out bearings and scored cylinders to dilution of the oil is not considered fully justifiable.

Principles of Soil Mechanics, I-VIII, C. Terzaghi (Engineering News-Record, 95 (1925), Nos. 19, pp. 742-746, figs. 5; 20, pp. 796-800, figs. 3; 21, pp. 832-836, figs. 4; 22, pp. 874-878, figs. 6; 23, pp. 912-915, figs. 6; 25, pp. 987-990, figs. 4; pp. 1026-1029, figs. 2; 27, pp. 1064-1068).—A series of eight reports of studies on the engineering properties of soils, conducted at the American Robert College, Constantinople, Turkey, are reported.

I. **Phenomena of cohesion of clay.** These studies indicate that the cohesion of clay is due to two factors. The first of these is the pressure exerted by the surface tension of the capillary water, the tensity of which exceeds all other forces in soils. Swelling of clay is considered to be nothing more or less than the purely elastic expansion produced by the elimination of the surface tension of capillary water. Local evaporation of the capillary water or local flooding of the surface of clay deposits produces secondary stresses, the intensity of which is far greater than the weight of the heaviest structures, and which were found to be the primary cause of many vast soil displacements known as earth slips.

The second factor in the cohesion of clay consists in the fact that the properties of the water contained in voids of a width less than 0.0001 millimeter are not identical with those of ordinary water. In such voids viscosity and surface tension are increased in inverse proportion to the diameter of the voids, and the water loses its ability to evaporate. Thus the capillary water of the clays is, to a certain degree, solidified by the influence of the forces exerted by the molecules of the solid matter. Due to this fact the capillary pressure assumes far greater values than it would if the surface tension of the capillary water had its normal value.

II. **Compressive strength of clay.** These studies showed that the modulus of elasticity of clay in compression determined from cube tests at different moisture contents has a constant ratio to the capillary pressure. Capillary pressure was found to play the same part in the physics of clays as does intrinsic pressure in the physics of solids. The elastic properties of the clays are therefore considered to be qualitatively indentical with those of granular solids. It is concluded that them minimum requirement for describing a clay from the engineering viewpoint consists in presenting data on water content, specific gravity of the solid matter, and the lower limit of the plastic and of the liquid state of the clay.

III. **Determination of permeability of clay.** Studies of the validity of Darcy's law, Slichter's formula, and Hazen's observations with reference to clay and sand showed that the Darcy law is valid even for the semisolid state, and holds for percolation through clay of plastic consistency. Distinct departures from Darcy's law could be noticed only for semiliquid clays. Reducing the hydraulic grade from 50 down to 10 or 15 caused a rapid decrease of the coefficient of permeability, and this coefficient was fairly constant only at low heads. This phenomenon is explained by the fact that the structure of a semiliquid clay is honeycombed. Results obtained in certain evaporation tests indicated that the physical constants of the water may change when the capillary channels of a shrinking clay become reduced to a certain size. To provide for such changes in viscosity the formula for permeability of clay was modified to $k = \frac{C}{v_o} \frac{v_o}{v_t} \frac{(e-0.15)^{11}(1+e)}{(e-0.15)^{8} + \frac{c}{d^{8}_{w}}} d^2w$. In this formula k is the coefficient of permeability, C and c are constants depending on the nature of the grains as well as their size, v_o and v_t are the coefficients of viscosity of the water at 10 degrees C. and at a temperature of t, respectively, d_w is the effective size of the grains of clay, and e is the void ratio.

IV. **Settlement and consolidation of clay.** These studies showed that the consolidation of clay is the result of a decrease of moisture content under load. They indicate that the compression proceeds exceedingly slowly from the surface of the layer toward the interior. This is considered to explain the gradual increase of the settlement of structures resting on the surface of strata of plastic clay. The results of studies of settlement are taken to indicate that in order to compare two clays as to settlement, it is necessary to submit a sample of each to a test of such a nature that its outcome will depend on nothing but the value of the ratio of the slope of the pressure-moisture curve and the coefficient of permeability of the clay.

V. **Physical differences between sand and clay.** These studies showed that there is no essential difference existing between sands and clays other than those in grain size and shape. However, these two differences were found to be fully adequate for explaining the more obvious distinguishing features of the two materials. It was found that the volume of voids of clay may be 98 per cent of the total volume, while the volume of voids in sand is about 50 per cent at the maximum. Clay was found to shrink on drying while sand did not. Clay showed a very marked cohesion depending on the moisture content, while sand showed a negligible cohesion when clean. Clay was found to be plastic and sand was not. Clay was found to compress very slowly when a load was applied to the surface and was very compressible, while sand compressed almost immediately when a load was applied to the surface and was far less compressible than clay. In connection with the listed differences, loading of the horizontal surface of a water-soaked layer of sand was found to produce an almost instantaneous settlement, because there was little resistance to the escape of the excess water from the compressed material. On the other hand the low permeability of the clay resulted in an enormous resistance to the escape of the capillary water and therefore settlement under load proceeded slowly.

VI. **Elastic behavior of sand and clay.** These studies included compressibility and elasticity tests of sand, investigations of expansions and resaturation and of the ideal sand cube, and of the effect of lateral expansion. It was found that while Poisson's ratio for clay is approximately identical with that of metals, its value for sand corresponds to the average Poisson's ratio for crystalline rocks.

VII. **Friction in sand and in clay.** These studies showed that the quantitative side of every earth pressure phenomenon depends on the intensity of the frictional resistance acting within the soil. An attempt to characterize the phenomena of sand and clay friction and to indicate their quantitative features indicated that friction between smooth and absolutely clean surfaces of solid bodies is a purely physicochemical process and is caused by direct molecular interaction. Friction between imperfectly smooth surfaces of solid bodies involves not only these physicochemical causes but also a filelike action of each surface on the other. In sand the friction coefficient depends not only on the properties of the grains and the

structure of the sand, but also on the nature of the process which causes the slip and of that which preceded the slip. It has no definite value, but may be anywhere between the coefficient of internal friction and the coefficient of internal resistance. In clay the friction coefficient for medium and high pressures is remarkably constant. For low pressures, however, the value of the coefficient increases with decreasing pressure, because initial friction plays an important part, amounting to about 20 gm. per square centimeter. Rapid change of pressure produces a positive or negative hydrostatic pressure in the liquid component of the clay. The coefficient of friction does not assume its normal value until the hydrostatic pressure has become zero throughout the whole mass. In the preceding stage of the process the coefficient of friction may have any positive value, and is a function of the time.

VIII. **Future development and problems.** A brief statement of the origin and history of experimental study of soils is given and the objectives of future work in soil mechanics are outlined.

Disintegration of Portland Cement in Sulphate Waters, T. Thorvaldson, R. H. Harris, and D. Wolochow (Industrial and Engineering Chemistry, 17 (1925), No. 5, pp. 467-470).—Studies conducted by the University of Saskatchewan are reported.

The data on the action of sodium sulphate on Portland cement indicate that although the main action is the extraction of lime from the cement, during the later stages both silica and alumina are removed, owing possibly to the slight solubility of the hydrated aluminates and silicates in the liquids and to the formation of stable colloidal suspensions. The extraction is speeded up in the presence of sodium sulphate and the effect increases with the concentration, but there was no evidence of a difference in the nature of the reactions involved with water and with solutions of sodium sulphate. Under the conditions of the experiment, it appeared likely that in either case all of the calcium can be extracted by continued treatment. This is taken to indicate the importance of making impervious concrete even when in contact with fresh water only.

Further experiments showed that the presence of chlorides is not a contributing factor in the disintegration of cement by sulphates. Although solutions of sodium chloride alone produced a marked increase in alkalinity over that produced in distilled waters, yet a solution that was 0.5 molar with respect to both sodium sulphate and sodium chloride did not give an increase in alkalinity over 0.5 molar solution of sodium sulphate. As far as disintegration of cement in sulphate solutions was indicated by the increased liberation of free calcium hydroxide from the cement, it appeared that the presence of sodium chloride in 0.5 molar solution of sodium sulphate had no effect.

Data on the action of magnesium sulphate showed that this material reacts with the lime liberated through the natural hydration of the cement, and that the products are removed on account of their slight solubility. The liberation of free lime is consequently speeded up and continues until all the available lime has been removed and has reacted with the magnesium sulphate. The high percentage of lime removed indicated that if ultimate products of hyrolysis containing lime are formed, the calcium in these is at least partly replaced by magnesium.

It was found that in mixtures of sodium and magnesium sulphate the magnesium sulphate disintegration controls as long as there is any of that salt present. The sodium sulphate disintegration can begin only after the magnesium sulphate is removed and the alkalinity rises.

The data are also taken to indicate that the complete disintegration of Portland cement may take place in sulphate solutions without crystallization of substances, with a resultant increase in volume, having any important influence. On the other hand, it is pointed out that under certain conditions, especially when a structure is exposed to alternate drying and wetting, such crystal formation and frost action represent the final cause of the disruption of material already weakened through chemical disintegration.

Electrification of Sugar Plantations, G. L. Trist. (Facts About Sugar, 20 (1925), No. 46, pp. 1094, 1095, 1097).—Data on power and lighting equipment and its arrangement, care, and efficient operation under working conditions on sugar plantations in the Hawaiian Islands are briefly presented.

Vermin-Proof and Other Fencing, A. P. van der Merwe. (Union So. Africa Dept. Agr. Jour., 11 (1925), No. 4, pp. 338-350, figs. 5).—In a contribution from the Grootfontein School of Agriculture data on different types of fencing for the exclusion of vermin from agricultural lands are presented.

The Effects of Engine Operation on Lubricating Oil, L. T. Wagner (Jour. Soc. Automotive Engin., 17 (1925), No. 3, pp. 263-267).—Data are reported which indicate that the three major effects of engine operation on oil are complete destruction of part of the oil, physical and chemical changes in the oil, and contamination of the oil by foreign matter.

It is pointed out that the volatility of lubricating oil is important, since it must be converted into a gas before it can burn. The flash test, however, is of little value, and may be misleading, as it does not indicate the volatility of the entire mass. Ordinary temperature changes do not permanently alter the viscosity of an oil, but the specific viscosity is changed by relatively high temperature and by contamination.

Work of the Kansas Committee on the Relation of Electricity to Agriculture, H. B. Walker (Kan. State Bd. Agr., Bien Rpt., 24 (1923-24), pp. 144-152, figs. 9).—The proposed program of work of this committee is outlined.

Present Status of Rural Electrification in Kansas, H. B. Walker, G. S. Knapp, and W. E. Grimes (Kans. Engin. Expt. Sta. Bul. 16 (1925), pp. 47, figs. 24).—A study made by the Kansas Experiment Station in cooperation with the Engineering Experiment Station of the Kansas State Agricultural College to determine the character, kind, and extent of rural electrical service on Kansas farms from central power stations, and a study of types of farming in connection with services rendered, uses of energy for each type, amount of energy used, transmission problems, etc., are reported.

The results showed that the greatest appreciation of electric service by Kansas farmers is for illumination, and it is concluded that farm illumination outside of the home is a logical line of study. Illumination for poultry production, while found of value in special instances, was frequently considered impractical by the farmer. The conclusion is drawn that the use of electric incubators will be limited largely to commercial hatcheries, and the brooding of chicks on the farm will increase with the development of commercial hatcheries. Thus the electric brooder will have a wider demand for farm use than the electric incubator.

Sixty per cent of the farms of the State were found to use ice, and the development of a practical, reliable, and economical electric refrigerator for rural use is considered to be another logical line for investigation. The use of electricity for pumping, while established service, was found to offer greater promise for building up a rural electrical load than any other single service. Grain grinding, elevating, shelling, and cleaning were found to offer the best field of general farm development in motor belt work, while ensilage cutting and threshing if generally motorized must compete with the tractor.

Possibilities for a general utility motor were indicated, but the use of electric motors for drawbar work is considered to be as yet wholly within the experimental field. Electric milking machines were also found to be in the development stage, particularly for the smaller dairy farms.

The average farm user of electrical energy was found to use but little, if any, more current than the urban user, and line and transformer losses on many rural lines exceeded the amount of current used. It is stated that the volume of energy used is more important on rural transmission lines than the number of users.

Dairying as a type of farming is considered to be the most susceptible to electrification, and livestock farming also offers promise of providing a fairly good demand for volume of electrical energy. It is concluded that the use of electricity in grain farming areas will be limited largely to household uses, but that diversification will tend to improve electrification possibilities with this type of farming.

Two appendixes, one by G. S. Knapp on the use of electricity for irrigation pumping and the other by W. E. Grimes on Kansas agricultural tendencies are included.

Farmstead Water Supply, G. M. Warren (U. S. Dept. Agr., Farmers' Bul. 1448 (1925), pp. II+38, figs. 25).—This bulletin supersedes Farmers' Bulletin 941 (E. S. R., 40, p. 91). It presents information concerning the sanitary and engineering principles underlying safe, serviceable, and permanent water systems for farmsteads.

Cork Lined Concrete Houses, H. Whipple (Concrete [Detroit], 27 (1925), No. 5, pp. 15-20, figs. 12).—This type of insulated dwelling construction is described and profusely illustrated.

Stresses in Helically Reinforced Concrete Columns, A. W. Zesiger and E. J. Affeldt (Amer. Soc. Civ. Engin. Enoc., 52 (1926), No. 1, [pt. 3], pp. 3-40, figs. 4).—The object of this paper is to analyze the effect of helical reinforcement on the concrete core of a helically reinforced concrete column, and to develop formulas for the stresses occurring in the steel and concrete with varying percentages of reinforcement. The purpose is to indicate the lines along which further research would be highly beneficial.

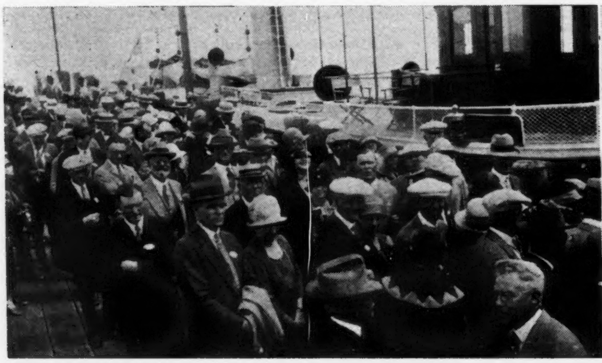
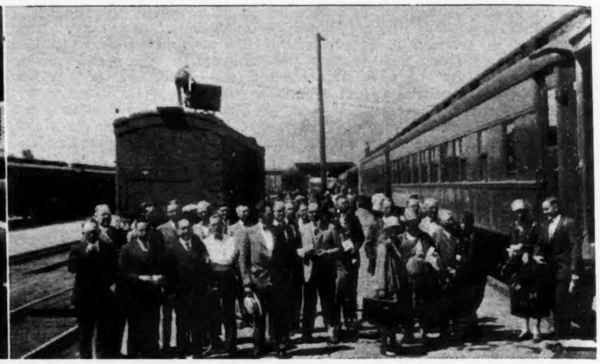
It has been found that plain concrete columns of lengths up to at least 80 ($l \div r$) fail in shear rather than in compression. Before a plain concrete column can fail in shear, the imposed load must be sufficient to overcome the shearing resistance of the concrete and the frictional resistance of the material to incipient motion along the impending plane of rupture. Helical reinforcement is effective in resisting a shearing failure of the concrete core, and if sufficient reinforcement is used it is possible to preclude a shearing failure of the concrete. Helical reinforcement has little effect in preventing crushing of the concrete core of the column.

Even if the concrete shell outside the reinforcement in a helically reinforced column cracks off under a load, only a little greater than is necessary to cause failure in an unreinforced column of the same dimensions and quality of concrete, the reinforcement tends to neutralize the effects of local imperfections in the concrete, thus increasing the reliability of the column. Furthermore, warning of impending failure is given in the reinforced column by the cracking of the outer shell of concrete. It is considered permissible, therefore, to allow a lower factor of safety and correspondingly increased working stresses in helically reinforced columns.

It is concluded that a rational analysis of the stresses in the steel and concrete of a helically reinforced concrete column is possible.

Standard Specifications for Corrugated Metal Pipe Culverts (U. S. Dept. Agr., Dept. Circ. 331 (1925), pp. 6).—The text of these specifications, adopted by the American Association of State Highway Officials and approved by the Secretary of Agriculture for use in connection with federal aid road work, is given.

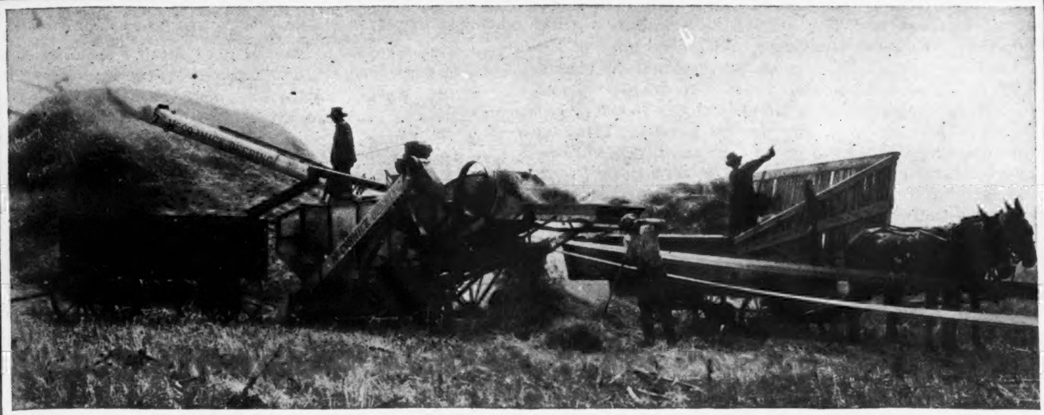
Lake Tahoe Meeting of A. S. A. E. in Pictures

(Left) Members and guests enjoying boat ride around Lake Tahoe. (Right) Party enroute from the East "poses" for picture at Ogden, Utah


Two views of barbecue dinner enjoyed by attendants at the 20th annual meeting among the "tall timber" at Tahoe Tavern

A group of those in attendance at the 20th annual meeting



A. S. A. E. Meetings

A NUMBER of meetings of the sections and divisions of the American Society of Agricultural Engineers of exceptional interest and importance to members of the Society and others are being scheduled. Second to none of the Society's functions is the holding of professional meetings, not only for the presentation and discussion of papers and reports on new developments in agricultural engineering, but perhaps more important still for the purpose of bringing together for social intercourse the men engaged in the various phases of agricultural engineering work. As a matter of fact, the main underlying reason for the Society's existence is to help develop the individual member and improve his condition. To this end A.S.A.E. meetings render a real service.

The first meeting of the fall and winter months, as now scheduled, is that of the North Atlantic Section. This meeting will be held October 11, 12 and 13 at State College, Pennsylvania ,at which place the Pennsylvania State College is located. It will be the third meeting the section has held. The first two meetings were unusually successful, considering the comparatively recent organization of the section, and the third one promises to be even more outstanding.

While no definite date has as yet been set, it is planned to hold the first meeting of the Southwest Section some time during the month of October. This will be the first formal meeting of the section, and it is planned to hold it at Dallas, Texas. According to tentative arrangements the program will feature farm equipment.

The usual late fall meeting of the Farm Power and Machinery Division will be held this year, December 1 and 2, at the Hotel Sherman, Chicago. Preparation of the program is now well under way, and it promises to be of more than usual interest. The leading topics scheduled include the combined harvester-thresher, the corn picker, tractor fuels, and the trend in tractor design. This meeting will combine the joint tractor meeting of the A.S.A.E. and the Society of Automotive Engineers originally scheduled for March 25 and 26 and later postponed. It will be a three-day meeting all together. Farm machinery will be featured the first day and the agricultural application of the tractor the second day; the program of these two days will be presented by the A.S.A.E. The S.A.E. will present the program on the third (December 3), which will feature internal-combustion engineering as applied to tractors.

A meeting of the Farm Structures Division, which will feature a better farm homes conference, will be held at Chicago in February.

New A.S.A.E. Members

G. A. Atherton, general manager, California Delta Farms, Inc., Stockton, Calif.

T. G. Bard, engineer, Berylwood Investment Co., Somis, Calif.

P. H. Gray, rancher, Covina, Calif.

O. J. Jennings, Albuquerque, New Mexico.

H. R. Kingsley, structural engineer, The Hollow Building Tile Association, Chicago, Ill.

Charles Kuntz, educational director and organizer, International Polytechnic University, Moscow, U.S.S.R.

H. R. Linn, heating engineer, American Radiator Co., Chicago, Ill.

F. E. Price, extension engineer, Oregon Agricultural College, Corvallis, Ore.

J. C. Robert, promotion agent, Clay Products Association, Birmingham, Alabama.

L. H. Trott, sales engineer, The New Jersey Zinc Sales Co., New York, N. Y.

D. R. Van Horn, writer, Walton, Neb.

Transfer of Grade

I. F. Reed, Orchard, Nebraska. (From Student to Junior Member.)

W. L. Ruden, 2630 R Street, Lincoln, Nebraska. (From Student to Junior Member.)

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the June issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

E. N. Bates, marketing specialist, U. S. Department of Agriculture, Portland, Ore.

A. B. Crane, extension specialist in agricultural engineering, State College of Washington, Pullman, Wash.

Judge Charles Dunn, manufacturer of insecticides, Lock Haven, Penn.

D. F. Fenn, director of agricultural school, Hampton Normal and Agricultural Institute, Hampton, Virginia.

Rush Hamilton, salesman, Standard Gas Engine Co., Oakland, Calif.

Wilhelm Holzwarth, representative, Advance-Rumely Thresher Co., Berlin-Steglitz, Germany.

F. H. McCormick, engineer, electric range division, Edison Electrical Appliance Company, Chicago, Illinois.

Otto H. Meili, time study department, Chain-Belt Company, Milwaukee, Wisconsin; designing and testing, Meili-Blumberg Co., New Holstein, Wisconsin. Address, 2030 Jackson St., New Holstein, Wisconsin.

W. L. Paul, machine designer, John Deere Plow Works, Berkeley, California.

F. C. Scobey, irrigation engineer, U. S. Department of Agriculture, Berkeley, Calif.

Clara Woolworth, director women's division, educational department, J. B. Colt Company, New York City.

W. D. Wright, rural supervisor, Empire Gas & Electric Co., Geneva, New York. Address, c/o E. C. Lautenslager, P. O. Box 5, Geneva, New York.

Transfer of Grade

R. A. Palmer, R.F.D. 1, Port Clinton, Ohio.

Employment Bulletin

Men Available

AGRICULTURAL ENGINEER, married, age 29, 1922 graduate of Iowa State College in agricultural engineering, now assistant engineer in construction department of International Railways of Central America, desires position where permanent residence is possible, preferably experimental or production work, or management of reclamation project or large ranch. Ten years experience in general farming with power equipment, experimental and teaching work, and construction work. Can speak Spanish, also some French and German. MA-130.

WORKS MANAGER available. Seventeen years experience in the designing and manufacture of tractors, harvesting machines, and earth-working tools. Sales experience in United States, Canada, England, France, and Italy. Write for interview. MA-132.

AGRICULTURAL ENGINEER, graduate of University of Illinois, nine years teaching experience as assistant professor in one of the largest universities of the central west. Eleven years manufacturing experience with one of the large tractor and farm implement builders. Experienced in production, design, and management. Desires position preferably as extension agricultural engineer or experimental or production manager work. MA-133.

AGRICULTURAL ENGINEER, single, age 26, graduate of University of Nebraska, College of Agriculture, with two years' practical experience in advertising and sales work, would like position in similar work preferably in South or Central America. Very good at drafting, designing, and photography of farm implements. Can speak a little Spanish. Has had a few articles published. Would submit samples of work. MA-134.

AGRICULTURAL ENGINEER, 1917 graduate Iowa State College, ten years experience in highway; city; drainage; irrigation; concrete products; and concrete construction work. Available for immediate employment. MA-135.

Positions Open

AGRICULTURAL ENGINEER wanted to fill position at Preston, Cuba. Knowledge of Spanish desirable but not absolutely necessary. Farm experience, knowledge of gas and steam engines, and such machinery as ordinarily used on large sized farms is essential. Salary $150.00 to $175.00 per month, according to experience. Single man preferred. PO-116.